THE

ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

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	Page
Artificial Selection of Motormen	1013
Two New Forms of Electrolytic Cell for Production of Bleaching Solutions (*illus.*)	1015
The Manufacturers' and Contractors' Associations	1016
Reviews	1017
Royal Commission on London Traffic	1018
A New Primary Cell	1019
Tramway Rating	1019
The Faraday Society	1020
Legal	1020
Our Legal Query Column...	1021
Correspondence	1021
The Strike Clause	1025
Litigation or Compromise?	1026
Physical Society	1026
Electric Power Appliances in the Mines of Europe	1027
Business Notes	1028
Recent Extensions of the Bradford Corporation Electrical Undertakings (*illus.*) (*concluded*)	1031
Camborne and Redruth Tramway (*illus.*)	1035
Electricity Supply Accounts	1040
City Notes	1041
Stocks and Shares	1042
Share List of Electrical Companies	1042
Market Quotations	1043
Electric Tramway and Railway Traffic Returns	1044
Switch Construction (*illus.*)	1045
The Design of Direct Current Machinery (*illus.*) (*continued*)	1047
Testing Tires Electrically (*illus.*)	1049
Institution of Electrical Engineers:— The City and South London Railway: Working Results of the Three-Wire System applied to Traction, &c. (*illus.*)	1050
New Patents Applied For	1052
Published Specifications	1052

THE

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ARTIFICIAL SELECTION OF MOTORMEN.

THERE has been trouble recently on the Manhattan Elevated between the train-men and the owners, on account of an ordinance calling for periodic physical examination. Such an examination has to be passed when a man enters the company's service, but hitherto no strict and regular watch has been kept on the depreciation to which the human frame is as prone as any other complex machine. A strike, however, has been averted, and the company has carried its point.

Once more we take the opportunity to impress on our British managers their duty to their employers, to the public who use their cars, and to the employés themselves.

No service calls more for the human agents to be in possession of unimpaired health and a complete set of senses in perfect working order, than the safe carriage of passengers through the streets of a town; yet how many of our tramways can prove by doctors' certificates that their motormen are not afflicted in some non-visible way, so that they are for ever menacing the safety of the lives entrusted to their care? How many managers indeed take the trouble to put probationers through the simplest sense tests? We fear that the percentage is very small. Yet what is it that stands in the way of such an elementary safeguard? Surely not the cost of the examination, which, even if carried out by a doctor independent of the employés' sick club, would cost something trivial like half-a-crown, a very insignificant premium to pay for an undoubted insurance against accidents. Neither, surely, could it be a lack of foresight on the part of a large and usually intelligent body of men. The danger must have been recognised even when the one-horse car held the road.

If neither of these, then, is it some vague fear of the men, some notion in the case of an existing tramway, that the men will resist the test, or in the case of a new-born system, that men will not be obtainable under such conditions? If none of these things prevents examination, what is it that does?

Something blocks progress even if it is nothing more than a new scheme involving the payment of money without tangible, direct, or proveable return, and which has to be formulated first, and then placed before the committee or the board, and finally put into working order and kept there.

Of course, the committee and the board ought to be sufficiently alive to their own interests to know that the best results can be obtained only with the best material, and that nothing but rigorous examination by an expert can be depended upon to reveal flaws in material.

Apart from everything else, it is much more pleasant both for the man and the employer, and very much easier for the

latter, to sack the man before he is taken on, rather than afterwards, if we may use an Hibernicism; and we are confident that the list of dismissals and the spare list will be decreased soon after physical examination is introduced. The number of applications will diminish, too, so soon as the physically unfit know that they have no chance of escaping the doctor.

Benefit to the concern will result in another indirect way, from the fact that a body of sound men uncontaminated by defective or degenerate members, is much more likely to exhibit a high standard of morals and intelligence than the old mixed crowd.

The present period of depression in trade is a strikingly fit opportunity to weed out the physically undesirable, and to pick the best out of the distressingly large number of unfortunates who have been thrown out of employment.

The probability of a strike following the adoption of such a precaution is remote, because, in the first place, the majority of the men will have no cause to fear the scrutiny of the doctor, and will be aware of the fact; and, secondly, no strike of public servants could succeed without the general support of the public themselves, who are entitled to demand that they shall be protected, and who would have the sense to see that compulsory physical examination can be a hardship only to such motormen as might be sources of danger.

Logically, it follows that, in order to guard the undertaking, and the passengers, from drivers who develop some prohibitory defect during their service, medical examination of every driver must be made at regular intervals, and it was against this that the Manhattan Elevated drivers kicked. At 25 a man may be physically perfect, while 10 or 20 years later he would not pass the doctor if he had to go to him again, although he may believe himself to be as sound and as fit to drive as ever.

Sentimentally, it is hard to get rid of this man, but, in the interests of the public, there should be no alternative. Knowing the risks, every man should fortify himself against the evil day by some form of insurance, and it should be possible to do this with, and by the assistance of, the company or corporation, if the employers have the best interests of their men really at heart.

The human factor must be reckoned with always in street traffic, and it will pay to eliminate uncertainties as much as is possible. This can be done by artificial selection only, the process of natural selection chiefly now in vogue being of much too slow a nature.

Jone's New Primary Battery.

On another page we give a condensed account of a new cell designed by Mr. Jone, of Chicago, by the aid of which it is claimed that some 50 or 60 per cent. of the chemical energy of natural coal may be recovered as current, the oxidising material being eventually the atmosphere. The whole cycle of operations involved appears to be somewhat complicated, and at least one of the intermediate reagents required, viz., nitric acid, is not a particularly nice thing to handle; but Mr. Jone states that a new oxidant will shortly be available which will be capable of direct regeneration by means of air. Although this is not a "carbon cell" in the proper sense of the word, for the positive plate is tin, the apparatus seems an honest attempt to meet Ostwald's dictum that the oxidising agent must be in the place where the carbon (tin) is not. The chemical process in Jone's cell is a combustion of tin to stannous oxide balanced by a reduction of mercuric oxide to metal on the opposite side of a carbon diaphragm, the electrolyte being aqueous caustic potash maintained at a temperature of 160° C. It follows from this, using Thomsen's data referring to ordinary temperatures, that the E.M.F. of the cell cannot exceed 1·52 volts for the oxidation of the tin, less 0·66 volt for that of the mercury, or 0·86 volt net; which compares with the 1·05 volts of the ideal carbon cell, and the 1·84 volts of the zinc cell. Nevertheless, since Thomsen's value for the heat of formation of stannous oxide (not dissolved is alkali) is 70·2 large calories, if it is a fact that 3 lbs. of tin yield 1 E.H.P.-hour, the internal efficiency of the cell becomes 92 per cent. It must be pointed out, however, that Mr. Jone's thermal estimates for the entire process, require revision, because the loss of heat by radiation and conduction from a metallurgical furnace certainly does not always occur in arithmetical proportion to the temperature inside; nor is so little as 50 per cent. of the energy of zinc manifested as current in common primary cells. Still, if we may accept the authority of Dr. Beyenbach, we learn that some 6 ozs. of anthracite or 8 ozs. of bituminous coal will develop 0·746 KW.-hour, or 645 large calories; and, inasmuch as this weight of coal should yield 1,500 to 1,800 large calories on combustion, the efficiency of Mr. Jone's complete apparatus should be from 36 to 43 per cent. over all, without making any allowance for the wastage of the zinc and of whatever oxidant may be employed in the future; that is to say, assuming the waste heat from the quantity of coal mentioned is ample to provide the rest of the necessary warmth.

Labour Clauses and Foreign Tenders.

Can it be that the London County Council is coming to its senses? That question of labour clauses has been hammered at for years, and at last something of an appreciation of the injustice of past procedure is really finding its way home to the mind of those who have time and time again invited tenders in such a way that the foreign manufacturer was especially favoured. British firms in getting out estimates have had to make provision for unreasonable conditions respecting hours of labour, rates of pay, and so on, and to do so have increased the amount of their tenders in order to recoup themselves for forced compliance with unusual conditions. But the foreign manufacturer may tender low, promising anything and everything that may be asked, and get the contract, giving a sly grin in his sleeve respecting the very remote chances of those labour conditions being complied with. We are heartily glad to see that an "inquiry" is about to be made, and we hope that the enlightenment which will come as a result of the investigation of Continental conditions will lead to a reversal of the old procedure. But there must be no incompleteness or half-heartedness about the inquiry. The Council several weeks ago requested the Highways Committee to inquire as to the rates of wages, hours of work, mining royalties, &c., obtaining in Belgium and other countries supplying rails for the London tramways. The Committee regard the matter as one of some elaborate difficulty. Can that be their reason for not properly facing the question at an earlier date? They suggest sending an expert adviser over to make inquiries, with one of the assistants from the office of the Council, and add:—

> It will also be necessary to obtain in Belgium and Germany some assistance in the way of interpretation and local knowledge, which could probably be accomplished by means of introductions. Having carefully considered the matter, we have come to the conclusion that this is the only way in which a satisfactory and perfectly independent report can be secured. We do not anticipate that there will be any difficulty in obtaining the names of representative firms whose works can be visited, and introductions to residents in the particular localities affected. If our proposal be adopted, we think that it can be carried into effect at a cost of about £150. We may add that we think that the necessary inquiries should, in the first instance at any rate, be limited to the districts in Belgium and Germany where the rails in question were made.

We are glad to note that, as announced in our "Contracts Closed" columns to-day, two British manufacturers are to share between them £80,000 of contracts for tracks, slot and conductor rails for some of the Council's new tramways. The Committee's reasons for recommending this course, after making a full comparison of the tenders of the British firms with those of foreign works which were able to quote lower, but with incomplete compliance with the specifications and conditions, are stated elsewhere.

TWO NEW FORMS OF ELECTROLYTIC CELL FOR PRODUCTION OF BLEACHING SOLUTIONS.

By JOHN B. C. KERSHAW, F.I.C.

In two articles published during 1900 and 1901,* the present writer discussed at some length the electrolytic methods of bleaching paper pulp and textile fabrics. In these articles the various forms of electrolytic cell which up to that date had received industrial trial, for preparing such solutions, were described, and in the final sections of these two articles, comparisons of the electrical efficiencies of the various types of cell, and of the costs by the old and new methods of bleaching, were made. Since the date of the publication of the two articles named, little new information relating to the preparation of bleaching solutions by electrolytic methods has become available for publication, and no new figures for the efficiencies of the cells described two years ago, have been published. The fall of nearly 45 per cent. in the value of bleaching powder, owing to the collapse of the sales agreement between the Le Blanc and the Electrolytic manufacturers, has undoubtedly checked the development of the subsidiary industry, and with bleaching powder selling at £3 15s. per ton in this country, it is doubtful whether any of the cells for producing sodium hypochlorite can compete with the older method—in the matter of cost.

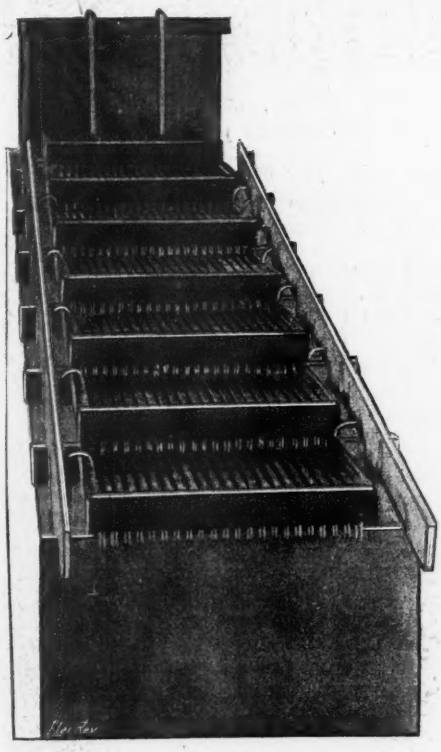


Fig. 1.—General View of Seven Hypochlorite Cells of the Fabrik Elektrische Bleichapparate, Bavaria.

But, as pointed out in the previous articles on this subject, hypochlorite of soda, as a bleaching agent, possesses numerous advantages when compared with calcium hypochlorite as usually sold in the form of "bleach," and even under the less favourable conditions as regards comparative costs now obtaining in the bleaching industry, there are cases in which it would be advisable to employ the more expensive salt as bleaching agent.

Further, the open competition between the Le Blanc and Electrolytic makers, in the opinion of those best qualified to judge, is not likely to continue indefinitely, and therefore with the lapse of time bleaching powder may be expected to return to its old value of between £5 to £6 per ton.

Under these circumstances, the following descriptions of two new forms of apparatus for the production of hypchlorite solutions, may not be without interest to readers of this paper, although at the moment the industrial and financial prospects of such cells and processes may seem to be somewhat overclouded.

The first of these new cells for the electrolytic production of bleaching solutions is protected by German Patents Nos. 118,450 and 121,525 granted to the Fabrik Elektrische Bleichapparate in Pfronten, Bavaria. The following description and figures for its working efficiency are drawn from the *Elektro-Chemische Zeitschrift*, Vol. ix., pp. 142—144, and from the *Papier Zeitung*, Vol. 27, pp. 70—71.

Fig. 1 shows a general view of a series of the cells, seven in number, arranged on the step system, which is adopted in working them. Each separate unit consists of a horizontal plate formed of a hard black ebonite-like material, provided with longitudinal narrow channels, in which strips of a platinum-iridium alloy of peculiar form are fixed and form the electrodes. The main conductors run alongside the series of plates, and electrical contact with the side or terminal electrodes is made, by bent strips of the same alloy. Each of the plates is provided with 22 longitudinal channels, and the electrodes are so designed and arranged that the total area of the anode surfaces is 5 to 10 times greater than that of the cathodic area.

A 9 per cent. solution of common salt is contained in the storage vat at the upper end of the series of plates (see fig. 1), and from this the solution finds its way in a number of streamlets, which follow the channels and the electrodes, over the plates to a similar storage vat at the lower end. This liquor, containing a certain amount of hypochlorite, is then pumped back to the upper tank, and the flow over the plates is repeated until the percentage of free chlorine has risen to the limit desired.

In the example shown in fig. 1 each plate absorbs 7 amperes at 100 volts, or about 1 E.H.P., and the seven plates produce 1 kg. of free Cl. per hour. By varying the number of plates and the number of electrodes (the plates are worked with two terminal electrodes and 20 or more secondary electrodes), direct currents of an E.M.F. up to 220 volts, and of any current intensity can be utilised. A plant of 60 plates, each absorbing 20 amperes at 220 volts, would thus utilise 360 E.H.P., and would (according to the inventors) produce 1,600 kg. free Cl. from 8,000 kgs. salt, equivalent to 4,500 kgs. bleaching powder, per 24 hours. The maximum limit of free chlorine obtainable in the electrolyte with this form of cell is stated to be 30 grams per litre, but it is considered preferable to produce a solution containing only 12—20 g/l free Cl, and to dilute this with ten times the volume of water before using it for bleaching cotton or cellulose tissues. The chief novel features of this form of hypochlorite cell are, the division of the electrolyte into a number of streamlets before submitting to the action of the current; and the use of electrodes with the surface area of the anodes many times greater than the corresponding cathode surfaces. This second feature is, of course, designed with the idea of lessening the reducing action of the hydrogen liberated at the cathode, and it will no doubt prove of some value in realising this end.

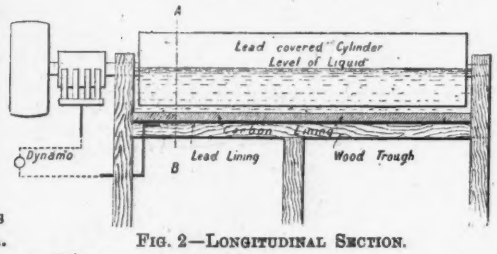


Fig. 2—Longitudinal Section.

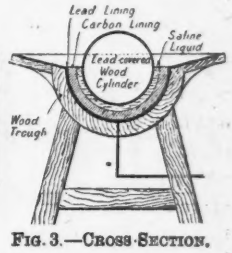


Fig. 3.—Cross-Section.

Atkins Hypochlorite Cell.

The second apparatus for the electrolytic production of bleach solutions which has recently been brought before the public is the invention of G. J. Atkins, of London, and is protected by English patent No. 5,596, of 1901. The following details of its design and working efficiency are drawn from the descriptions given in this patent, and in an illustrated article appearing in the *Engineer* of February 13th, 1903.

* *The Electrician*, June 15th, 1900; *The Textile Manufacturer*, April 15th, 1901.

A wooden trough of semi-circular cross-section forms the cell, and is lined first with lead, and then with carbon blocks shaped to fit the wooden vessel; these blocks form the anodes of the cell. A wooden cylinder, also lead-covered, revolves on bearings placed at the ends of this trough, and forms the cathode of the cell. A copper collecting ring and brushes at one of the bearings supply the electrical connection for this revolving cathode. The trough is filled with a 10 per cent. solution of sodium chloride, and electrolysis of this solution proceeds in the ½-in. space which separates anode and cathode.

Figs. 2 and 3 show diagrammatic longitudinal and cross-sections of the Atkins cell. The cell with which the preliminary experiments have been conducted is 10 ft. in length, and the cathode cylinder is 2 ft. in diameter. A current of 1,500 amperes at 3·5 to 4 volts is used to operate this cell, and a current density of 50 amperes per square foot is reported to be obtained. This represents a cathodic area of 30 sq. ft. for the submerged half of the cylinder.

The revolution of the cathode is designed to lessen polarisation and reduction by the hydrogen liberated at the negative pole, and it is said to be effective in attaining this result. No figures are given in the *Engineer* article, for the electrical efficiency of the apparatus, and in the absence of these it is impossible to compare its yield of available chlorine with that of the cells described in the earlier articles on this subject.

The yield of the cell designed by the Bavarian firm for Elektrische Bleichapparate is stated to be 1 kg. of available chlorine for 4,900 watt-hours (a seven-plate apparatus yields 1 kg. Cl. per hour). It is useful to compare this yield and efficiency with that of the cells described in the *Electrician* on June 19th, 1900; and, for the purpose of comparison, the table of efficiencies given in that article is reproduced here:—

YIELDS AND ENERGY EFFICIENCIES OF VARIOUS FORMS OF HYPOCHLORITE CELL.

Name of cell.	E.H.P.-hours per kg. active chlorine.	Energy efficiency per cent.
Corbin	11·1	21 per cent.
Hermite	10 2	23 ,,
Kellner	9 4	25 ,,
Woolf	7 5	31·5 ,,
Vogelsang	6·6	35·5 ,,
Pfronten (Bavaria) ...	6·57	35·9 ,,
Theoretical figures ...	2·36*	——

*The theoretical figures in the original article, were, by an error in calculation, given as 4·78 E.H.P.-hours, and consequently, although the relative positions were correct, all the efficiency percentages were rendered too high. The corrected efficiencies are given in the above table.

According to the published figures, therefore, the new German cell is the most efficient of the cells in actual use for the production of hypochlorite solutions, and as the special features of its construction appear to be based on scientific principles, it is probable that the cell will be adopted by some of the firms who have decided to instal electrolytic bleaching apparatus. As already pointed out, however, the economic conditions at the moment, owing to the abnormally low price of bleaching powder, are prejudicial to the extended use of electrolytic bleaching methods.

As regards other uses for hypochlorite solutions, it is reported that the Atkins cell is to be adopted in connection with a gold-mining scheme in Australia, for the purpose of supplying a solution for leaching the crushed and roasted ore. Hypochlorite solutions when treated with sulphuric acid, liberate chlorine compounds capable of dissolving gold. The cost of sulphuric acid in Australia is, however, high, and as more economical methods of obtaining free chlorine exist, the writer is dubious concerning the permanent success in Australia of the Atkins method for treating auriferous minerals. Time will show whether this criticism is justified.

Trowbridge Lighting.—The T.C. has decided to appoint Mr. Geo. Pearson, solicitor, and chairman of the Bristol Electricity Committee, to examine the proposed agreement with Messrs. Presland & Frippard, for the lighting of its area.

THE MANUFACTURERS' AND CONTRACTORS' ASSOCIATIONS.

[COMMUNICATED.]

THE agreement between the members of the Electrica Contractors' Association and the Manufacturers' Association has at length been arrived at, after considerable patience and perseverance on both sides; and although some of the stipulations are laid down with tolerable clearness, the agreement lies rather more in the spirit than in the letter.

If we mistake not, the real strength of the agreement rests in the appointment of a joint committee of arbitration. If the members of this committee can themselves afford to sacrifice their individual and personal interests for the general good, much can be done; certainly, on the first two or three decisions of this committee depend whether it has the confidence of the community, and no light task, therefore, has been imposed upon them in the adjudication of subjects between the contractors and manufacturers.

As we see it, one of the weaknesses of the contracting trade is the ease with which new aspirants to the industry, practically without capital, are at liberty to enter the trade; in course of time some of these rise from the ashes of their former selves, and develop into *bonâ fide* contractors; the others alternate between occasional jobbing on their own account and employment by a contractor, both of which are a source of weakness to the *bonâ fide* contractor.

It would appear that manufacturers are mainly responsible for the creation of the mushroom variety of contractor. No genuine contractor who has been trained for his work needs the provision of wiring tables, and these, as found at the back of some manufacturers' catalogues, are in many cases the sum total of the "technical knowledge" upon which the experience of the bogus contractor is built. The ease with which goods can be obtained, the lending of testing sets, &c., all combine to the exploitation of bogus contractors, who probably, in their brief and inglorious existence, convince their customers in their early fears as to the dangers of electricity, and spoil the market for genuine contractors.

The *bonâ fide* contractor also seeks recognition from the higher branches of the profession, and if the selection of members of the Contractors' Association is carried out with sufficient care, the recent suggestion of one of our correspondents respecting the issue of lists of contractors by the Contractors' Association to consulting engineers, may do much to uplift the general status of contracting, when probably the recent suggestions as to waste of energy in tendering might be judiciously put to the test. It may also be urged, with some show of reason, that contractors who are members of the Institution of Electrical Engineers, might reasonably hope for the recognition by the Institution, of contracting, as an important branch of the electrical industry. The recent wiring rules prove the interest taken in wiring matters by the Institution, and the election of a representative contractor to the Council of the Institution of the Electrical Engineers might be a desirable recognition of that branch of the profession which is responsible for the efficient and due carrying out of those rules.

What is a contractor? What is a manufacturer? The questions obtrude themselves at every point in the consideration of the agreement. Apparently, whether a firm considers itself a manufacturing or contracting house, depends upon the branch in which it is engaged at the commencement of its business. Viewing the fact that many manufacturers do contracting, and many large contractors manufacture, we see a constant difficulty with which both branches will have to contend.

As contractors are binding themselves to support those firms who are members of the Manufacturers' Association, it follows definitely that they cannot deal with their fellow contractors who manufacture, and apparently what we would call a manufacturing contractor is not eligible for membership of the Manufacturers' Association. This has, doubtless, not been overlooked, but it will entail a great deal of hesitancy on the part of an aspirant to membership as to which flag he will swear his allegiance to, though it must naturally be assumed that applicants for membership would wish to join the Association with which the bulk of their work most closely identifies them.

An argument which finds some favour, chiefly from the contracting side, is that firms engaged in business in both branches, and having them run separately, should be at liberty to join both Associations, but we opine that the time is not far distant when the trade, as a result of its organisation, will have unravelled many of the entanglements which surround it, and the manufacturers and contractors finally understanding that their interests are identical, will combine their organisations, and unite as the Electrical Association of Great Britain and Ireland. Such a body, with the common interest of the trade at heart, would be in a position to correct any abuses and repress the irregularities freely complained of on both sides, with sub-sections representing the various interests, whether contractors, manufacturers and cable and plant manufacturers. The whole matter seems to present so many involved points, that fusion must in the end be inevitable, unless in consequence of the work of the Associations the trade reaches that millennial perfection which shall render all such associations unnecessary and superfluous.

REVIEWS.

Elementary Telegraphy and Telephony. By Arthur Crotch. London: E. & F. N. Spon.

The author of this book, who is one of the staff of the Engineer-in-Chief's Office, General Post Office, and is a Silver Medallist in Telegraphy, has done a distinct service in compiling the work. Speaking generally, the book may be described as a condensation of the well-known "Preece and Sivewright's Telegraphy," and it is intended to cover the intermediate ground between electricity and magnetism proper and the twin subjects of telegraphy and telephony; for this purpose the book is extremely well designed. The general contents are as follows:—I. Magnetism; II. Terrestrial Magnetism—Magnetic Theory; III. Static Electricity; IV. Electrostatic Induction—Condensers; V. Dynamic Electricity—The Voltaic Cell; VI. Primary and Secondary Cells; VII. Resistance, Current and Electromotive Force; VIII. Effects of Current—Galvanometers; IX. Induction; X. Cross-Section—Combined Resistances; XI. Joining-up of Cells—Universal Battery System; XII. Telegraphy: Single Needle—Sounder; XIII. Relays—Double-Current Working; XIV. Wheatstone A B C—Steljes Recorder; XV. Differential Duplex; XVI. Bridge Duplex; XVII. Submarine; XVIII. The Telephone; XIX. Telegraph and Telephone Lines; XX. Elements of Testing.

It will be seen that the ground covered is limited, and yet is sufficient to enable those who are desirous of obtaining information without too much detail to acquire the same at their leisure. Written by a practical man, the information given is thoroughly sound and up to date, whilst the general "get up" of the book is in Messrs. Spon's usual excellent style. We have no hesitation in heartily recommending the work.

Whittaker's Electrical Engineer's Pocket-book. Edited by Kenelm Edgcumbe. London: Whittaker & Co. 1903. Price 3s. 6d. net.

This new work is intended to give not merely a heterogeneous collection of rules and formulæ, but rather a synopsis of condensed and accurate information on each subject dealt with, supplemented by references to publications containing more detailed treatises. Certain sections have been specially written for this volume by authors whose names are attached. It is no easy matter to adequately review a new work of this kind; but, so far as we have been able to discover, the data are correct and abundant, and the information on the whole of a useful description. Naturally, the book is not faultless, and errs at times in the selection of the matter; for example, under the head "Three-wire Low-pressure Direct-current System," no idea whatever is given as to what the system is, what ratio of sections is generally employed, or any other practical data, while its chief advantage is said to be the fact that it allows of storage! It is stated on the next page that 100 cycles per second is, up to the present, the frequency most largely in use, but that there is a distinct tendency towards the adoption of frequencies of about 50; as a matter of fact, 50 is the most common frequency.

However, we have found very few instances of this nature, and the more we examine the book, the more we like it. Besides the usual introductory sections, electrical tables, &c., there are articles on magnetism and electricity; measuring instruments; dynamos, motors and alternating-current machinery (very fully treated); transmission of power; traction; central stations; switchgear; a very useful section on estimating, with average prices; electrochemistry; and legal information. The index, a very important part of the work, is quite inadequate, and should be greatly extended; but, nevertheless, the book is unquestionably a valuable addition to electro-technical literature.

Calculating Scale: A Substitute for the Slide Rule. By W. Knowles, B.A., B.Sc. London: E. and F. N. Spon, Ltd. 1903.

This is a curious attempt to provide an equivalent for the slide rule, in the shape of two adjoining scales—one divided logarithmically, the other uniformly—100 in. long, divided into strips 5 in. long, which are printed side by side on four pages. Calculations are made by adding or subtracting lengths, &c., not as in the slide rule by a mechanical, but by a mental or arithmetical process. Doubtless, as the author states, results can be obtained by this means as accurate as those from a four-figure table of logarithms; whether with less trouble, as he suggests, is somewhat doubtful, and we should certainly prefer a 20-in. slide rule.

Patent Office Library Series.

The staff of the Patent Office Library is indefatigable in its efforts to facilitate the labours of searchers, both in the Search Department proper and in the excellent library of technical literature with which it is associated. To this end additions are constantly being made to the above-named series, and new editions of the existing guides are being issued to keep the contents as nearly up to date as possible. We need do no more here than draw attention to the series, which includes a guide to the Search Department, and a number of subject lists relating to specific branches of technology. Those who have occasion to conduct such researches cannot do better than arm themselves with the appropriate handbooks, which are published at the Patent Office at the uniform price of 6d. each.

Munro and Jamieson's Pocket-Book of Electrical Rules and Tables. By J. Munro and A. Jamieson, M.Inst.C.E. 16th edition. London: Chas. Griffin & Co., Ltd. 1903. Price 8s. 6d.

The only way to deal with this inquire-within-upon-everything seems to be the random shot system. We are not prepared to read it through *seriatim!* We learn from the preface that much matter has been deleted; this is a process which, though no doubt painful, is quite essential if a work of this description is to be kept up to date. It is most annoying, on reference to a formula-book, to find half-a-dozen different and discordant rules for ascertaining a desired result; the dictum of the best authority should alone be inserted. There is a danger also of descriptive matter entering too largely into the work; but the book under consideration is remarkably free from this common fault. A number of important new measuring instruments and methods have been dealt with in the new edition, and new tabular data relating to the resistances of metals and solutions have been added. Modern permeability tables have been inserted, though Hopkinson's classic, but now obsolete, tables, are still retained in place.

Turning to the index, we do not find an entry for "Single-phase Motors," or even for "Motors—Single-phase." Looking up "Motors—Alternate-current" as the nearest approximation, we find (p. 496):—"*Alternate-current Motors.*—Motors to work in circuits supplied with alternate currents are now a practical success; for example, Mordey's alternate current machines."

In the year 1903 we need not comment on this extra-

ordinary paragraph—which stands alone. There are, however, elsewhere a few pages on polyphase motors.

We also looked for "Slide rule"; we regret to find no mention of this indispensable companion of the engineer. Next, "Power factor," but with a similar result; likewise "Choking coil," "Welding," "Automobile." These subjects may be dealt with in the volume; we only say they are not indexed. "Booster," when turned up, proves to relate only to the alternating current type. We must in justice add that we have sought other test references, and found them properly indexed. The index is the soul of such a work as this, and ought to receive as much attention as the text.

From the foregoing it will be seen that we do not yet regard the "Wee Bookie" as perfect; but we admit that it is well on in that direction.

Watch Repairing, Cleaning and Adjusting. By F. J. Garrard. London: Crosby Lockwood & Son.

As far as we are aware, there is no book, in the English language at least, which is on precisely the same lines as that of Mr. Garrard. No man is so competent to write on any mechanical subject like that in question, as one who has served an apprenticeship at the trade and has worked at the bench, provided, of course, that he has literary talent also. "Wrinkles" innumerable are known to the bench-worker, and these are seldom heard of by the outsider, to whom, in many cases, they would be invaluable.

The author has included, in the 19 chapters of which the work consists, a great amount of matter very concisely expressed; the illustrations are numerous and very clear. The various defects which are likely to be met with in watch work are very plainly mentioned, and although doubtless the information given is not absolutely complete, it is certainly very full. We can confidently say that all interested in the subject may possess the book with very great advantage.

The Internal Wiring of Buildings. By H. M. Leaf. Archibald Constable & Co., Ltd. Price 3s. 6d.

This work, "revised and enlarged," is the second edition of the original, published in 1898. The enlargement apparently consists of an additional chapter on electricity meters and of certain fittings used for high voltage circuits. As for the revision, we cannot state where this has taken place without detailed reference to the first edition, but it is signalised to a certain extent by omission as well as by commission. It was somewhat unfortunate for the author that the 1903 revised rules of the Institution of Electrical Engineers were published at or about the time when his book was in the press; but we understand that the publishers have expressed their willingness to exchange any copy of the book containing the 1897 Rules for an issue which they have prepared since the new rules were published. Presumably the references in the book to the old rules will have been corrected by the author, otherwise confusion will most certainly result, as the issue at present under review contains several statements not quite up-to-date. For instance, on p. 59 we are told that "both positive and negative conductors should not be placed in the same casing,"—although the 1903 rules allow of this being done. Again it is said of casing that "in spite of the rival claims of other methods . . . . it will probably hold its own on account of its cheapness and the ease with which it can be fixed." We believe, however, that it has been clearly proved that when wires are threaded through close-joint conduits (however reprehensible this generally adopted system of wiring may be) the cost of installing is less than with casing, mainly on account of the labour. We are glad to notice that the author plumps for thorough work and deprecates the undue cutting of prices at present in vogue. His chapter on "Costs and Estimates for Wiring" is particularly of interest to the consumer, as is also the new chapter on "Electricity Meters," at least so far as the first part is concerned, which contains a lucid exposition of the various systems of charging. We do not much care for the system of numbering the illustrations; in the same chapter the same number is used more than once, and many figures are altogether unnumbered. With the exception of this and of a few statements which have escaped revision, such as we have indicated, the book can be recommended to the student who is leaving college to take up practical work, or to the pupil at electricity works, or in a wiring firm. To the wireman, pure and simple, it would be of little use, and to his "mate" who is learning, none. When Mr. Leaf next revises his work, we suggest that it could be greatly improved by a more concise and systematised method of chapters and paragraphs, instead of what is now rather a conversational style.

ROYAL COMMISSION ON LONDON TRAFFIC.

The Royal Commission on London Locomotion resumed its sittings on Thursday of last week at the Westminster Palace Hotel, Sir David Barbour presiding.

Mr. A. J. Hopkins, the late chairman of the Works Committee of the Marylebone Borough Council, gave evidence on behalf of a conference of the Metropolitan Borough Councils of Hampstead, Kensington, Paddington, St. Marylebone and St. Pancras. The witness stated that the conference was strongly opposed to the proposal of the London County Council to amend the Standing Orders of Parliament, under which Borough Councils had the right to grant or withhold their consent in connection with tramway schemes. They were also of opinion that when street widenings were needed for any proposed new tramways, the cost should be borne entirely by the tramway undertaking and not one-third only, the remaining two-thirds being charged as improvements. He would suggest that the L.C.C. should be in the same position as a company in promoting tramway schemes. If a company was willing to pay out of its own pocket for the necessary widenings, the Borough Councils should not be placed in a worse position when the L.C.C. were the promoters. The effect of a tramway in a busy thoroughfare was not to relieve but rather to create greater congestion of traffic, especially in the case of a good service of of cars, as all the ordinary vehicular traffic was driven to the sides of the road. They did not consider that busy thoroughfares, even if they formed part of a great main road, should be used for what was practically a railway, to the great disadvantage of other wheeled traffic. The conference had considered the matter of tube railways, and advocated a Standing Committee, mainly composed of Metropolitan Members of Parliament, to consider all new schemes of tubes or underground railways affecting the metropolis. They were of opinion that Borough Councils should have power to construct subways under principal thoroughfares at congested points, and where tramways crossed at the junction of two or more roads, the tramway undertaking should contribute to the cost of such subways. A most frequent cause of the blocking of the thoroughfares was the breaking up of the streets by gas, water and other companies.

Alderman Tyler (Bermondsey) gave evidence as to the main thoroughfares in the borough which required widening.

Mr. A. F. Hills chairman of the Thames Ironworks, Shipbuilding and Engineering Co., of Blackwall, stated that he was a large employer of labour, and had given much time and thought to the question of providing the necessary travelling facilities for workmen in London. In 1901, he, in conjunction with several financiers, promoted the North-East London Railway Bill, and the Piccadilly and City Railway Bill, and in 1902 an extension was promoted from Hammersmith to Piccadilly, and further north at Tottenham and Walthamstow, so as to form a complete system of underground railways from Hammersmith *vid* Piccadilly and the Strand to the City, and thence to Walthamstow and Tottenham. He had had considerable experience of Parliamentary Committees, and he submitted that in many respects their procedure needed amendment. Through a quarrel between the firm of J. S. Morgan & Co., and the London United Tramways, the Bill which they promoted for a through route from the east to the west of London was wrecked, although they had spent £80,000 on promoting it. To obviate the extravagant expenditure and waste now involved by the present system of promoting Bills in Parliament, and for the delays and difficulties that were now put in the way of trade enterprise, apart altogether from the legitimate opposition of competing interests, he would suggest the creation of three authorities—an administration authority to deal with the existing condition of affairs; a development authority to deal with all schemes for the improvement of the existing condition of affairs, and of a confirming authority to settle finally all promotions, whether of private or public enterprise. The administration authority should have supreme administrative control of all streets, roads and locomotion within the county, and should generally administer the roads for the general convenience of the public at large. It would also consider the best methods of improving the existing means of communication, whether by widening, or relaying, or planting with trees, or making new thoroughfares or cutting new connections The development authority should consist of seven members, three paid, to be appointed by the Board of Trade, a peer and a Member of Parliament, and a representative each of the L.C.C. and the City Corporation. That authority would deal officially with all schemes, whether promoted by private or public enterprise, for the extension and improvement of London communications. The paid members should devote their whole time to the solution of the pressing problems of London

locomotion. The authority should be possessed of judicial functions alone; they should have no power to initiate new schemes, or to finance or in any way to undertake the responsibility of new development, but they should be empowered to hear all suggestions, and they should be authorised to make recommendations to promoters who appeared before them for the purpose of harmonising and co-ordinating independent schemes with a view to securing the greatest common advantage in the public interest. All new schemes for the betterment of London locomotion, whether promoted by the administration authority or by public or private enterprise, should be brought before this authority, and in the event of their approving any scheme they should be empowered to issue to the promoters a provisional order with such recommendations attached as they might think fit. With regard to the confirming authority that should consist of five members, being a Joint Committee of Peers and Commons. Promoters should appear before that Committee in the ordinary way, and the ordinary deposits would be required, but the double expense of appearing before two separate Committees of the Lords and Commons would be avoided. With the establishment of those three tribunals it was probable that the best solution of the present perplexed problem of London locomotion would be found. Even then, however, the real root of the difficulty would remain untouched; the most pressing question being the adjustment of the respective interests of private and public enterprise.

Witness instanced the case of tramway undertakings, and said it was only under special circumstances that the Huddersfield Corporation was allowed to work its tramways, thus creating a precedent. In view of the fact that since the L.C.C. took over the South London tramways, in 1899, they had succeeded in reducing a working annual profit of £104,000 to a loss of £4,000, it seemed plain that some very prompt interference should be taken for the protection of the helpless ratepayers. He would suggest that the Commissioners should make a recommendation to Parliament that the Municipal Purchase Clauses of the Tramways and Electric Lighting Acts should be abolished. Those clauses, in his opinion, had resulted in England—the home and nursery of engineering enterprise—being years behind such countries as Hungary and Roumania, whether as regarded electric tramways or electric lighting, and it was time that those foundation stones of municipal self-aggrandisement, and those stumbling stones to commercial development, should be cast into the sea of oblivion. At the present time there was going on a death struggle between private and public enterprise, and the true remedy for that civil and commercial warfare was the co-partnership of private and public enterprise. He did not see any insuperable difficulty in creating such a co-partnership. He considered that municipal bodies needed to be saved from themselves, as regarded their extravagance and inefficiency, and the moment was opportune for a declaration by the Commission on that important point.

On Friday evidence was given by Mr. W. L. Emden, Mayor of Westminster, who once more advocated the construction of subways to avoid street openings. The Town Clerk of Westminster followed with evidence bearing in the same direction.

The Commission adjourned until January 7th.

A NEW PRIMARY CELL.

A new form of cell, to which the attractive title of "the coal battery" has been given, is described by Mr. Hugo Jone, Sc.B., of Chicago, in a recent issue of the *Western Electrician*. This is an apparatus intended to develop electrical energy from coal (*viâ* tin) and air (*viâ* nitric acid and mercuric oxide). In its simplest form the battery consists of an outer steel vessel containing metallic tin as the positive element, a porous cell of carbon containing a carbon negative element, mercuric oxide as the oxidant, and an aqueous solution (2 : 1) of caustic potash, maintained at a temperature of 160° C., as the electrolyte. The tin is electrolytically attacked at the expense of the mercuric oxide on the other side of the diaphragm, falling to the bottom of the outer vessel as stannous oxide; the mercuric oxide is reduced to metal, and sinks to the bottom of the porous pot, whence it is withdrawn by means of a siphon. The mercury recovered is dissolved in nitric acid, and the mercuric nitrate is heated to convert it into fresh oxide ready for further service, the acid vapours evolved being treated with air and steam to regenerate the nitric acid. The stannous oxide is reduced to metal in a flat-hearthed furnace by means of coal, and the surplus heat from this reduction is caused to effect all the reactions previously described. In this way, except for inevitable losses, only coal (of any kind) and atmospheric air are consumed, and in a somewhat roundabout fashion the current is said to be generated from carbon and oxygen.

Systematically arranged, the plant includes a reverberatory furnace for the reduction of the stannous oxide. The products of combustion pass along flues, first raising steam in a boiler, next heating a horizontal drum through which a spiral conveyor forces the mercuric nitrate, then playing round the sides of the galvanic elements, and finally passing to the shaft amongst the coils of a pipe in which the air required to oxidise the nitrous acid and to feed the furnace is warmed. The mercury recovered from the cells is forced into a closed and jacketed pan standing over the plant, where it is treated with nitric acid and steam from the boiler. On opening a valve, the mercuric nitrate falls into the drum previously mentioned. The nitrous fumes evolved in that drum and in the pan, together with some steam, pass into an adjacent condenser, where they are oxidised by means of hot air, yielding nitric acid again which is collected in a suitable receptacle.

The cells stand in one of the flues packed for some depth in sand or slag wool to insulate them electrically, and all the plant is carefully arranged to avoid losses of heat. In each cell the porous carbon pot is slung centrally by an insulated joint from the closed metallic cover of the outer vessel. Arranged concentrically within or around this support is a stirrer for the mercuric oxide within the cell, and a set of brushes to remove the stannous oxide from the tin electrodes in the outer vessel; these are rotated mechanically. There is also a siphon for the removal of the mercury, while the oxide of tin falls into a basket. The tin plates hang by an electrical connection from the cover of the outer vessel, which thus becomes the negative pole; the positive pole is the portion of the porous pot support which lies within the sleeve that insulates it from the rest of the cover.

On the assumption that the plant is so large that the waste heat of the furnace suffices to heat the cells, the efficiency of the cell itself is claimed to be 85 per cent. by the inventor, or 90 per cent. by Drs. Thurlimann and Beyenbach (Professors of Chemistry in the Monadnock School of Assaying at Chicago). According to Beyenbach, the consumption of the cell is 3 lbs. of tin per E.H.P.-hour. The E.M.F. is said to be 1·06 volts, a cell holding 1·5 "gallons" of liquid yielding 23 amperes with an external resistance of 0·02 ohm. Mr. Jone claims that the efficiency of the whole apparatus, in terms of the latent chemical energy of the coal burnt, is about 66 per cent.; Thurlimann says about 49·5 per cent. Jone's argument as to the ultimate efficiency runs thus:—The efficiency of the reduction of zinc compounds by means of coal is about 2·6 per cent.; of this half is wasted in the ordinary zinc cell, whose coal efficiency is therefore 1·3 per cent. In the reduction of stannous oxide, however, the coal is completely burnt to CO_2, for CO reduces SnO, but not ZnO. The efficiency of SnO reduction is therefore 10 per cent.; but since the reaction proceeds at half the temperature needed for ZnO, the loss by radiation, &c., is "halved," and the actual efficiency becomes $10 + \frac{90}{2} = 55$ per cent. Since, moreover, the SnO from the Jone cell is freshly precipitated, it requires only "half" the usual time to reduce it, and so the whole efficiency becomes $55 + \frac{45}{2} = 77$ per cent. Alternatively, the text-books quote about 25 per cent. as the efficiency of the thermal reduction of tin stone (SnO_2), which makes the efficiency of the new battery 25 per cent. of 85 per cent. —*i.e.*, 21·5 per cent. But the reduction of SnO_2 requires a temperature of 1,000° C., while that of SnO occurs at 500° C.; this again halves the loss of heat [and apparently represents the efficiency of Jone's apparatus to be 52·7 per cent]. Dr. Beyenbach asserts that the 3 lbs. of metallic tin oxidised to the state of stannous oxide per E.H.P.-hour developed can be regenerated by a consumption of ½ lb. of anthracite or ¼ lb. of common coal; and since 3 lbs. of common coal are required to yield an equal amount of electrical energy when a steam engine is employed, "Mr. Jone's battery affords the means for saving much fuel."

Owing to the fact that several patent applications are still pending, certain improvements in the apparatus cannot be described at present. The inventor states that he is now able to dispense with mercuric oxide as an oxidant, so that the use of nitric acid as an intermediate reagent is no longer necessary. The substance now employed as depolariser can be reoxidised directly by atmospheric oxygen. The rotating brush for the tin, and the moving stirrer for the new oxidant, are no longer required, and several mechanical improvements have been effected which simplify the construction of the whole plant.

TRAMWAY RATING.

A question of unusual interest has recently arisen in connection with the distinction between a tramway and a light railway. As our readers are doubtless aware, the differences between a "tramway" and a "light railway" are more real than apparent. They appeal more to the legal mind than to the mind of the man in the street; for instance, the West London Tramway running to Kew, Richmond, &c., is, in all outward appearance, the same as the London County Council system to the south of the Thames, yet the first is really a light railway, while the last is a tramway in the eye of the law.

As we have said, the differences between a tramway and a light railway are mostly legal, that is to say, the procedure under which the necessary powers are obtained is different, and they are worked under different statutes, orders and regulations. Once he has learnt that any given system is a "tramway" or a "light railway," the lawyer has but little difficulty in answering elementary questions. Certain obscure points, however, do arise from time to time, which serve to show the danger of allowing the two systems to be carried on under the same conditions, but subject to different legal incidents. We venture to quote the following passage from the *Law Times*:—

"It is not always easy to distinguish a tramway from a light railway, but it is highly important to arrive at a conclusion on this point, because a light railway is exempt from rating to the extent of three-fourths of its total value. An interesting case on this subject was argued the other day before the West Riding magistrates in connection with the rating of the line on which the Bradford Corporation electric cars are run. The ultimate decision will, no doubt, be keenly watched, both by local authorities and tramway companies, in view of the enormous extension throughout the country of these methods of traction. In the Bradford case the Corporation had obtained powers under a local Act to construct a tramway from Thornbury to Stanningley, while a syndicate had also obtained powers to construct a light railway along the same route. Subsequently the Corporation took over the syndicate's undertaking, and elected to utilise their powers in place of the authority con-

ferred by their Tramway Act. The rating authorities, in claiming from the Corporation the full rate on their lines, argued that this line was indivisible from the whole system of the Bradford tramways, there being no line of demarcation, the same cars being run on them as were run over the tram lines, and the electric current being supplied from the same generating station. Further, that the Corporation were not entitled to the three-fourths reduction, because the lines were not used 'only' as a railway. The Corporation, on the other hand, relied on the fact that the Board of Trade certificate, given at the time the lines were opened, mentioned that they were constructed under powers granted by the Light Railway Order. The money for laying the lines had also been borrowed under the same order, and a separate account made of the capital expenditure. Their contention was, 'once a light railway, always a light railway.' The magistrates held that, although this might be a light railway, yet the Corporation were not entitled to the three-fourths reduction upon the rate."

It is difficult to understand the grounds of the above decision. From the lawyer's point of view, the fact that a light railway happens to run along the highway or street does not constitute it a tramway, and subject it to the legal liabilities of a tramway system. The difficulty has arisen owing to the fact that for some purposes a light railway is treated as an ordinary railway, while for other purposes it is treated as a tramway. For instance, an ordinary railway is exempt from rating to the extent of three-fourths of its total value; in the case under notice, the rating authorities declined to take the view that a light railway was for this purpose an ordinary railway. The magistrates apparently decided the case on the general ground that a tramway which makes use of a part of the road is lawfully rated at its full value because the roads are maintained out of the rates. They saw no reason why that which is really a tramway should be exempt merely because it happens to have been inaugurated under a different set of statutes and another procedure. We anticipate that the last has not yet been heard of this interesting case.

THE FARADAY SOCIETY.

The second ordinary meeting of the Faraday Society was held on Tuesday, December 8th, in the Library of the Institution of Electrical Engineers. Prof. A. K. Huntington presided.

Dr. Lehfeldt gave a short *résumé* of his paper on "The Total and Free Energy of the Lead Accumulator." The most convenient form in which to express the concentration of acid in the accumulator, for the present purpose, is by the molecular function (Z) of H_2SO_4. The heat of the reaction (in equivalents)

$$\tfrac{1}{2}Pb+\tfrac{1}{2}PbO_2+H_2SO_4 \rightleftharpoons PbSO_4+H_2O$$

may then be put in the form—

$$\chi-\frac{d\,Q}{a\,Z}$$

where χ is the heat of reaction between the pure materials (in absence of water) and Q is the heat of formation of the mixture $Z.H_2SO_4.(1-Z)H_2O$. Numerical values of this are calculated from the experimental data already in existence for the range $Z = 0$ to $Z = 0{\cdot}25$, and the results shown by a curve. The free energy can be put in a similar form. A curve is drawn for it, based on E.M.F. measurements, and the latter are compared with the vapour pressures (p) of dilute H_2SO_4 by the thermodynamic relation that takes the form

$$\log p = \frac{F}{RT}\left\{\int E.dx - Ex\right\}$$

(F = faraday. R = gas constant. E = E.M.F. T = absolute temperature).

Dr. Ogg sent in a short note in which he tested the numbers derived from Thomsen's formula, and compared them with those derived from Pickering's experiments. The former all lie below the latter, probably because the Thomsen formula does not absolutely represent the heat of mixture of H_2SO_4 and H_2O.

Dr. Lowry made some remarks on the basis of the sulphate theory, observing that sulphating is usually looked upon as a "disease."

Dr. Lehfeldt, in his reply, said that the adoption of the sulphate theory was justified by the fact that measurements of the changes of weight in the Pb, PbO_2, $PbSO_4$ and H_2SO_4 agreed tolerably closely with those deduced from the equation given in the paper. Sulphating, however, was not the same as the formation of sulphate during discharge, where only a film is allowed to form, and is immediately broken down by the current.

Mr. J. A. Sutherland, F.I.C., F.C.S., read a paper entitled "Bitumen in Insulating Compositions" (Part I.). The author points out that few or no reliable data have been published as to the use of bitumen for electrical purposes. The chief source of bitumen is Trinidad Lake, where there is estimated to be a quantity of 9 million tons, which appears to be renewed to the extent of 20,000 tons annually. Upwards of 150,000 tons are exported yearly. Bitumen is also found in Venezuela, California, and on the shores of the Dead Sea; it occurs in some limestone (asphalt) as an impregnation, about 10 to 15 per cent. being present, but it does not pay to extract it from this source. Its physical and chemical properties and constitution, which are fully dealt with in the paper, prove it to be infinitely superior to gas or coal tar for insulation and durability. Care should be exercised in refining; the temperature should be regulated, or the results will be injurious both for paving and electrical purposes. It is used in cable insulation, and very extensively for joint boxes and troughs for "solid laid" cables. No specification is, however, in use, and the object of this paper is to invite discussion and the views of electrical engineers to assist the author in the completion of his experiments, and to enable him to draw up a satisfactory definition of bitumen, so that users may secure the best results from its valuable non-hygroscopic and insulating qualities.

Mr. Gaster referred to Roumanian sources of asphalte. He had succeeded in freeing pitch from its carbon, which could then be used for arc carbons and electrodes, but the pitch still retained too much oxygen to be a satisfactory substitute for bitumen.

Dr. Steinhart strongly supported the author in his remarks regarding the desirability of arriving at some standard tests for bitumen. Physical, as well as chemical and electrical tests, were required.

Mr. E. Kilburn Scott said that some firms declared that refined pitch was as satisfactory as bitumen. Leakage troubles, especially where cables were laid round curves, were often caused by the creeping of the cable—which could be prevented by the use of wooden bridges, and was not at all the fault of the filling-in material.

Papers by Mr. Cowper-Coles and Dr. Perkin were held over, on account of the lateness of the hour, until the next meeting.

LEGAL.

Cowell *v.* The St. Pancras Borough Council.

In the Chancery Division of the High Court of Justice on Thursday, December 17th, before Mr. Justice Joyce, Mr. Hughes, K.C., applied for an injunction in respect of an alleged nuisance by the defendants' electric light plant in Great College Street, Camden Town, the nuisance being by vibration, noise, smell and dust, the dust coming from a refuse destructor. The learned counsel said that the only solution of the difficulty was for the Borough Council to buy up the plantiff's house. They had bought all the private houses in Great College Street between the works and Pratt Street. The nearest point of the generator station was only 40 or 50 ft. away from plaintiff's house. The works were put in operation in May last. Complaint was at once made, and plaintiff had delayed proceedings from time to time on the representations of the defendants that the nuisance, if it existed, would be put an end to shortly. The evidence was very strong as to vibration, and it was stated that ornaments in some of the houses were shaken by it, and that the vibration interfered with the possibility of sleeping. The defendants had three 750-H.P. engines at work, and they said there was considerable vibration; but if a sufficient time was given them—say, nine months—the nuisance would be abated.

Mr. Justice Joyce: If I grant an injunction, I should have to give the defendants some time to remedy the nuisance.

Mr. Younger, K.C., who appeared for the defendants, said that if his Lordship granted an injunction, 3,000 consumers would be deprived of light, and 22 miles of streets would be in darkness. It was the old case of the makers of the engines. They said it took time to adjust engines of this sort, and they were having elaborate experiments made to put the thing right. The defendants had met the plaintiffs in the most handsome way possible, and they were trying to perform their statutory duties with the least possible inconvenience to the public. He was prepared to say that, if the result of what they were doing was that the vibration could not be put right, these three engines would be taken away.

Mr. Justice Joyce suggested that the case was one for an early hearing, and, after some discussion, the trial was fixed for January 19th next.

Brooker and Others *v.* The Urban Electric Supply Co.

In the Chancery Division of the High Court of Justice on Thursday (December 17th), before Mr. Justice Joyce, Mr. Hughes, K.C., moved for an injunction to restrain the company from so carrying on their works as to cause a nuisance by vibration, smoke and noise. The learned counsel stated that the plaintiffs had gone to Weybridge to live in rural quiet, but they found that the defendants were carrying on their works in such a way as to cause them a nuisance.

Mr. Younger, K.C., for the defendants, said the works were commenced in May, 1902, and this was no case for an interlocutory injunction. The first-named plaintiff himself carried on a steam laundry, and there must be vibration in his works.

Mr. Hughes, K.C., said it had also been suggested that the vibration came from oil mills a quarter of a mile down the river.

Mr. Justice Joyce said he would not grant an injunction on the motion, which must stand over until the trial. He would advance the hearing, and the parties could apply to fix a date for the trial.

The National Co. for the Distribution of Electricity by Secondary Generators, Ltd., *v.* Gibbs.

This matter came before Mr. Justice Farwell in the Chancery Division on Thursday, December 17th, for further consideration. Learned Counsel said the matter came before the Court for further consideration on the report of the Master as to the damages recoverable by the plaintiff company against the defendants, who was the administratrix of the estate of the defendant Gaulard, now dead. The judgment was on July 11th, 1901, when Mr. Justice Cozens-Hardy ordered an inquiry as to damages, in favour of the plaintiff company, from the

estate of Gaulard, for breach of covenant by Gibbs and Gaulard, who sold to the plaintiff company a patent which was bad. On an admitted counterclaim judgment was entered against the plaintiffs for £2,581. The Master found damages for the company for the amount of £11,600, payable from the estate of Gaulard by reason of the breach of covenant in the agreement. The learned counsel asked for judgment for that amount.

His Lordship said that, as the executrix did not admit assets and did not appear, that could not be done. All he could do was to send the case back to the Master on the usual administration decree.

Order accordingly.

Patent Exploitation, Ltd., *v.* American Novelty and Manufacturing Co. Ltd.

In the Appeal Court last Saturday there was down in the list a motion for security of costs in this appeal. It was agreed, however, that, as there was an appeal pending in another case, by the same plaintiffs, to the House of Lords, the present appeal should stand over to enable the parties to consider the decision in the other case.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"X" writes:—"Your answer to 'Inquirer' in your issue of November 27th is interesting to us, inasmuch as we have a similar case to deal with, only in our instance the Town Council holds the provisional order (although it has not yet commenced the erection of the necessary plant, and has, by resolution, objected to allow us to supply.

"Briefly, the facts are as follows:—A railway company, whose line goes through our property, is anxious that we should supply it with current for lighting two stations, paying us a price per unit to be agreed upon.

"We propose to run bare copper overhead wires (110 volts) to the railway company's boundary, it dealing with the current on its own property. Between our generating station and the railway there are no roads, either public or private, to cross, and the whole of the land intervening is in our holding. The railway company's line, alongside which its mains would lead, both crosses under and over public roads by bridges, but it would not, of course, be necessary to disturb the road surface in any way.

"We shall esteem it a favour if you will state whether, in your opinion, we shall be justified in proceeding to supply the railway company in the face of the resolution by the Town Council objecting to our doing so."

***It cannot be too often pointed out that the Electric Lighting Acts confer no monopoly of the supply of electricity in a district where there happens to be a provisional order. This rule applies whether the supply is in the hands of a local authority, as in the case put by "X," or in the hands of a company. The effect of a provisional order is merely to give facilities for the breaking up of roads, and the general carrying out of necessary works, while by way of return to the public the "undertakers," as the holders of the order are usually styled, are bound to supply current at uniform rates to every person in the district. But the undertakers can place no restriction upon the supply of electricity by any private person to his neighbours; the Legislature never having thought it wise to restrict private enterprise in this way. Of course, if any person who wishes to grant such a supply finds it necessary to cross public roads, the local authority, provided that it owns the fee simple of the road, may interfere by preventing his suspending wires over, or laying them under, the road. But no difficulty of this kind arises in the present case.

In the circumstances, the only statutory enactment which "X" will have to observe, is Sec. 4 of the Electric Lighting Act, 1888, which provides that where in any case any electric line or other work may have been laid down in any . . . . position for the purpose of supplying electricity in such a manner as not to be entirely enclosed within any building or buildings, or where any electric line or work so laid down or erected may be used for such purpose otherwise than under and subject to the provisions of a license, order or special Act, the Board of Trade, if they think fit, may . . . . serve upon the person owning or using, or entitled to use, such electric line . . . . a notice requiring that such line shall only be continued or used with due regard to the public safety, and subject to such rules of that purpose as the Board of Trade may from time prescribe."

Regulations of this kind were published in 1897, and a copy of the same can probably be obtained at Eyre & Spottiswoode's, London, E.C., for a small sum. In asking for them "X" should ask for the "Regulations made under Sec. 4 of the Act of 1888." So far as we can gather from these regulations, there is nothing in them which prohibits the use of naked aerial conductors, provided they do not cross streets. Every aerial line must be attached to supports at intervals not exceeding 200 ft. where the direction of the line is straight, or 150 ft. where the direction is curved, or where the line makes a horizontal angle at the point of support. As an additional precaution, it would be well for "X" to submit his plans to the Board of Trade before he commences to erect.

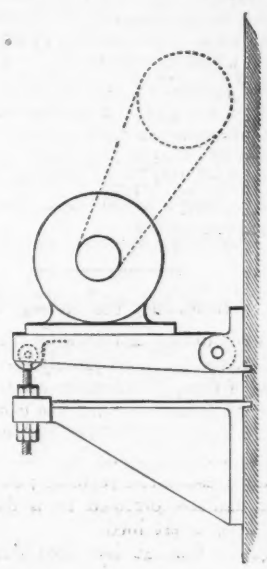
CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Device for Tightening Vertical Belts.

"Heavy shop" practice has recognised the necessity for travellers, and plenty of 'em, and cases now occur where the runway of a 40-ton crane is placed at a sufficient height to allow a couple of 10-ton ones to be worked on a lower separate level. Where groups of machine tools are to be driven from countershafts in bays where such a service of cranes exists, the power transmission problem may be aggravated by floor-room being denied to the motors.

To meet this "snag," a similar device to that sketched in last week's issue was adopted by a prominent electrical concern, the sketch of which will explain itself. Here the



shortness of the centres (2 ft. 6 in.) necessitated the use of the so-called "silent" high-speed chain-driving; and, after a lapse of four years since erection, it would be interesting to learn whether the vibration, presaged by Mr. Kitchen, has been the only trouble experienced. It may be noted that slotted holes in the hinge-plate obviate the necessity for slide-rails, "take-up" being effected by means of the single square-threaded screw which supports the hinge-plate horizontally.

E. Norman Rogers.

Newark-on-Trent,
December 15th, 1903.

Small High-Speed Motors.

Could you inform me, through your journal, if any firms make motors working at 4,000 to 5,000 r.p.m., sizes 10 to 30 B.H.P. direct current. Any information would oblige.

J. S.

Brighton Tramway Extensions.

In the Electrical Review for December 11th, "Traction Notes," a note bearing on this subject implies that just under half the members of the Council are opposed to progress; but this is not a fact. Eight out of 10 of the aldermen and councillors who are opposing this scheme and using the power which is rightly theirs as a saving clause by declining to vote, are doing so not because they do not believe in progress, but because they feel that the present time is premature for any further tram extensions along Preston Road, seeing that it will cost from £25,000 to £30,000. There is a line already almost parallel with the Preston Road, and it is thought that if a line is run along the Preston Road, and assuming that a profit of £900 is made, a serious falling off must necessarily take place on the

other route, *i.e.*, Baconfield Road. It is for this reason and no other, I believe, that about 20 members of the Council declined to vote as the only means of stopping this expenditure, at a time when we are having other large expenses looming which must take place. If the Council withdraw this scheme and the Bill which they are going to bring into Parliament, for another six years, use the £3,000 which they tell us the Bill will cost, add to that £2,000 more, and they could run the line down the short distance of the Drive into the heart of Preston village, which would meet all requirements for the next six years or so, and at the end of that time opposition will have vanished, and the time would be ripe for trams. But I venture to state that if a poll of the town was taken on the matter now, eight out of every 10 ratepayers, who pay their rates direct, are against this extension.

Now about the indignation meetings; I myself went to several of these meetings, and, as far as I could judge, it must have been the speakers who were indignant, to think that, after all their trouble in going round the town with a red herring, they could not get anyone to come to see them eat it. There was only one meeting in which there was anything like a full house, and that was at York Place School. Some say it was *packed*. I do not know about this; I can only say that a meeting of the unemployed was held in the same room the previous evening, and some of the same gentlemen who formed the indignation meetings also formed the unemployed meeting. This may have been the cause, and at this particular meeting a quarter of an hour was allowed the opposition to express their views.

Mautby Hill.

Electricity the Scapegoat.

Damage is undoubtedly sustained by the electrical industry owing to the statements so frequently met with in reports in the daily Press of fires, of which the origin is not obvious, to the effect that "it is believed that the cause of the outbreak will be found to be due to the fusing of an electric wire."

Such statements are in nearly all cases the outcome of the ignorance of an irresponsible reporter; they have no foundation whatever, and are corrected in a day or two when the real cause has been ascertained.

But by then the damage has been done, and frequently the correction is not observed by the non-technical reader, who has meanwhile decided that nothing will induce him—or perhaps more generally her—to install electric light.

Seeing the fact that electrical fires are such an extreme rarity and, in a properly designed and maintained installation, practically an impossibility, I write to ask you, Sir, if you cannot suggest some means of conveying this fact to your non-technical contemporaries in such a way as will induce them to discountenance the publication of the damaging remark in their reports of fires, at least until there appears to be some evidence to justify its being made.

The recent regrettable fire at Sandringham, which might have had such awful consequences, has of course, owing to the reports first circulated as to its probable origin, led me to write this letter.

F. W. E. Jones.

Leamington Spa, *December 17th*, 1903.

[Our correspondent will see that we referred to this subject in a leaderette in our issue of the 18th inst. We fear it is impossible to prevent the dissemination of these false reports.—Eds. Elec. Rev.]

Economical Speed Regulation with Continuous Current Motors.

Let me correct Mr. Frank Broadbent's impressions contained in the November 13th issue of the Electrical Review relative to the unnecessary elaboration, as he views it, that American manufacturers and designers are inclined to take in the matter of special systems pertaining to the art of independent machine operation by electric motors.

The form of motor construction hinted at by the writer in the October 3rd, 1903, issue of the *Electrical World and Engineer* seeks to overcome just such extremes and in itself does not involve intricacy or complication. Compared with the ordinary non-speed variable class of motors of similar horse-power at the minimum speed, the cost of construction is virtually the same, with the additional advantage that any range of speed increase is possible, retaining its horse-power rating at all points of the speed range.

As departures become necessary from the ordinary types, there arises, depending upon speed reductions, more or less elaboration in the amount of copper and iron. If the considerations involved in designing a variable speed motor were concluded at obtaining the requisite horse-power at the lowest speed, Mr. Broadbent's remarks would be justifiable, but such is not the case. Without burdening the subject with minor details, the increase of material and weight follows directly with reductions of speed, but where variable speeds are obtained by field regulation a still greater copper weight of the winding is necessary, the copper increasing about as the square of the ratio of speed variation. For instance, a 5-H.P. motor operating at 1,500 r.p.m. normally, to halve the speed (750 r.p.m.) and still permit by field regulation to return again to the original speed, 1,500 r.p.m., a ratio of variation of 1 to 2, will necessitate that the iron be doubled and the copper quadrupled; to obtain a speed ratio of 1 to 3 will necessitate three times the iron and nine times the copper.

The construction advocated by the writer involves but an imperceptible increase of material over the non-variable type, that is, beyond that required to develop the requisite horse-power at the minimum speed.

The matter of double armatures or armature surfaces is of secondary importance, being wholly an economic consideration in manufacturing, because of the unrestricted extent that wire may be heaped upon one armature division, resulting in corresponding diminution of the field strength, size and weight of that magnetic circuit division; but this may be left open to question, implying that there is but the one armature. The additional poles include the only elaboration incurring extra expense, which is barely noticeable in contrast with the direct extra cost for copper otherwise essential. Contrary to Mr. Broadbent's statements bearing upon the sufficiency of motors possessing a speed ratio of 1 to 2, or 1 to 3, the trade subject matter of any machine tool manufacture will reveal that this range is far from sufficient, other than serving for intermediate adjustments auxiliary to mechanical speed changing devices. A machine tool journal from which I quote, describes in a manner to be approximated, a milling-machine speed range 1 to 30, a shaper 1 to 20, a spindle boring machine 1 to 20, a lathe 1 to 16, a drill 1 to 8. One of the main objects of propelling such machines independently by electric motors, is the ease of control and manipulation, and the innumerable intermediate steps provided for by simple electro-mechanism.

Albert F. Hemingway.

Chicago, U.S.A., *December 5th*, 1903.

Steam Turbo-Generating Plant.

Mr. Barker in his letter dated the 14th inst. remarks on the amount allocated in our works costs to oil, waste, water and stores. I may say that the totals are quite correct and in no way interfere with the works costs per unit, but the allocation at the treasurer's department has not been accurate. Mr. Barker can, however, get all the details he desires by purchasing, as any other individual can, a copy of the Corporation abstract of accounts, which will give him all the details he desires.

H. N. Thomas,
General Manager and Engineer.

Tramways Department, Huddersfield.
December 17th, 1903.

Salaries of Municipal Officers.

May I draw attention to the extremely low salaries being offered by a number of municipal authorities to officials. Particularly is this so with regard to assistant engineers and chief clerks in electric lighting stations. One only needs to look back through the technical papers to see assistant engineers advertised for at salaries rarely exceeding £2 per week, and sometimes as low as 30s. Yet these men are expected to have had a thorough training in electrical and mechanical engineering, combined with central station experience of all kinds.

Then as regards chief clerks, one or two have recently been advertised for at 30s. and 35s. per week.

Chief clerks at 30s. per week!! What is the world coming to? It is disgraceful on the part of municipal authorities to offer a man about 26 years of age and upwards, with years of education and experience, the sum of 30s. per week for his services. It is not the money of a dustman or labourer, who probably cannot write his own name.

The trouble is that there are always men willing to take these positions, very often in the hope that they may lead to something better. But if all authorities start the business of getting officials at inadequate salaries, these men who live in hopes will always do so.

To look at the salaries offered, one would think that fat pensions were to be given to municipal officers when they reach the backwater of life, but at present such is not the case.

We often hear the remark, "How the poor live!" and these words would come forcibly to our minds if we pictured an official getting married, dressing respectably, and saving up for his old age on about 35s. per week. There are enough private firms paying salaries grossly inadequate without public bodies doing the same. Is it right to offer absurd wages just because men are always to be found willing to accept? A man out of work and starving through the bankruptcy of his firm would be glad to get work at £1 per week, though the position were worth three times the money; and who could blame him? No; the responsibility rests with the employer.

We all know that the important consideration with electric lighting stations is that they shall pay; but this is equally important with the majority of businesses. Moreover, a municipal authority is granted a considerable time to pay off capital expenditure for electric lighting purposes.

There is, unfortunately, always plenty of incompetency in business life; but what can be expected with such low salaries. Many a man would be an enthusiast at his work, but for the fact of being underpaid. You cannot expect a man of education to work hard if he is going to receive no more money than a dustman.

It is earnestly to be hoped that municipal authorities will act conscientiously in the matter of salaries to their servants, and may the time not be far distant when a scheme of pensions will come into vogue.

Desideratum.

[Our correspondent's complaint is only too well founded; we have often drawn attention to this matter, without avail. However, "Desideratum" may console himself with the comfortable reflection that what is saved from his salary goes to relieve the rates .... by slightly reducing the annual deficit.—EDS. ELEC. REV.]

Heating Capacity of Electric Radiators.

We note in your issue of 18th inst., a letter over the symbol "C^2R." We think the gentleman who wrote this might have had the courtesy to inform you that he had already been in correspondence with us regarding the matter, and we had acknowledged the mistake.

Under the circumstances, we think it is only fair to us for you to publish the letter that we sent to him upon the subject.

Falk, Stadelmann & Co., Ltd.,
G. E. SABB.

December 21st, 1903.

Dear Sir,—We are in receipt of your favour of 11th inst., and on referring back we find that for some unaccountable reason our works did wire your stove for 800 watts. Owing to the fact that it was ordered for two switches, they took upon themselves to do this, without first referring to you—the usual practice when only wiring for 400 watts is to put it on one switch.

However, if you will return same to us, at our expense, we will put it right for you immediately.—Yours truly,

FALK, STADELMANN & CO., LTD.
December 14th, 1903. (Signed) G. E. SABB.

We indignantly repudiate the statement made by Messrs. Falk, Stadelmann & Co., in the "Correspondence" columns of last week, that it was distinctly understood that we should insert no further letters in the columns of the ELECTRICAL REVIEW on the above subject if they lent us one of their stoves for the purpose of testing. It is true that we promised to cease our correspondence on their undertaking to withdraw certain statements made by them in their catalogue, but they were unwilling to do so.

Messrs. Falk, Stadelmann & Co. were quite right in supposing that it would be a matter of interest to us to learn that they had made tests on one of our heaters; it would, however, have been still more interesting to have had the full data referring to these tests, and it is a matter of surprise that they should not have volunteered to supply them, and thus expose the fallacy of thinking that an electrical heater can have a greater electrical efficiency than 100 per cent.

The absurd allegation that we have no knowledge of what our heaters can do, does not, we think, call for any reply.

Messrs. Falk, Stadelmann & Co. appear to be still of the opinion that to the peculiar construction of their heaters must be attributed their "superior efficiency," and, though it is improbable that anyone who has read the correspondence that has ensued will agree with them on this point, we feel sure that no one will, after perusal of "C^2R's" letter, dispute their claim as far as peculiarity of construction is concerned!

We have already given our reasons for not accepting Messrs. Falk, Stadelmann & Co.'s proposal in your issue of the 4th inst., and though we appreciate their discretion in having persistently ignored all theoretical considerations, we have, for this reason, no intention of continuing this controversy.

Thanking you for your courtesy in having afforded us the opportunity of airing a matter about which there has always been a considerable amount of misunderstanding.

The British Prometheus Co., Ltd.
H. SKIPWITH, *Manager*.

Kingston-on-Thames,
December 19th, 1903.

[Our correspondent's letter was somewhat heated—perhaps an unavoidable feature, considering the subject of this correspondence, and a testimony to the efficacy of electric radiators—and remembering the season, we have thought it justifiable to slightly cool one or two expressions. We think that this correspondence may now be dropped.—EDS. ELEC. REV.]

Packing Goods for Abroad.

In your last number I notice some remarks on packing goods shipped to South Africa. During my time in Cape Colony I had the pleasure (?) of working on some cells supplied to an electrical station at Cape Town by a well-known Colonial firm. These cells (250 in number) were German in make, and out of 240 cells, at least one-half were badly "pitted." Ten cells had holes in them as large as a crown piece, and had to be patched up before they would even hold water. The plates supplied with them were also very much the worse for wear, as the filling was quite loose. In the British Islands I have seen some American car cut-outs (or rather circuit-breaking automatic switches) packed with so much grease on them that they had to be taken to pieces and cleaned before they would work. From this I think that there is just as much bad packing in the States and on the Continent as in the old country.

Packer.

The Working of the Maximum Demand System.

It is possible that the explanation given in the foot-note to Mr. Hoyles's letter is correct. Another solution is, however, more probable. Most engineers having anything to do with the demand indicators mentioned, are aware that the latter have the peculiarity of sometimes altering their zero. For instance, a new instrument will be put on circuit reading zero correctly. After, say, three months' working it should, of course, on resetting read zero again. It is frequently found, however, that the level of the liquid is considerably higher. In a case which recently came under my notice, a 25-ampere Reason indicator was found on testing to have a zero error of 8 amperes. This suggests an adaptation of a well-known quotation to "Omnia mutantur et indicatores quoque mutantur in illis."

E

By watching the resetting of his indicator and taking care that there is no load on at the time, Mr. Hoyles can easily find out whether his indicator has taken for its motto—"Excelsior!"

R. A.

December 20th, 1903.

Edison v. Lead Accumulator.

For over two years the expectant public has awaited the advent of the Edison accumulator, which was going to revolutionise the electrical traction world, and give the poor a cheap and effective means of locomotion. At last the dreaded day arrived, and on November 26th a lecture was delivered on the Edison Accumulator by Mr. Hibbert, A.M.I.E.E. The lecture was carefully and skilfully prepared, but the figures and description of the runs are liable to mislead one. Great stress was put on the 908 miles' run, and the impression of the average man in the street was, that the car ran for 500 miles on one charge, and it is only by carefully reading and having a good knowledge of accumulators that one discovers that for a 160 or 170 miles' run the battery would require charging five or six times, so that for an average run of each 30 miles the battery would require a fresh charge. Other sources of error in which the non-professional may fall are:—(1) That all the measures are in ampere-hours, which may give a wrong conception of the energy of the accumulator. (2) The curves represent ampere-hours and the rates are not given, except for very small cells, where it is only 0·15, 0·35 and 0·65 ampere required for electric bells; and (3) the efficiency is very low. The worst lead accumulator will give 80 per cent. in power. Curve B has given an efficiency of 92 per cent. in power on traction load for over 14 months. How does this compare with runs of 80 to 100 miles made by lead accumulators? Only in one instance is the rate of discharge given, viz., the run on September 9th, the potential difference is referred to in curve 8. The energy curve A is such that a lead accumulator maker would be ashamed to publish or even show to his friends. We give the curve below as one in comparison with a lately made official discharge of a cell, and we regret that we have not in our possession authentic curves of discharges from the E.P.S., Rosenthal, Leitner, Elieson and Fulmen Companies, any of which would no doubt put the Edison accumulator in the shade. But we must deal with authentic facts, and this is why we enclose curves of the B and C. On comparison, these curves speak for themselves.

It would be interesting to know in what (apart from the magic name of Edison) his battery is superior to any of the above-named lead accumulators, as it seems, by the figures given, to be inferior in every respect, and supposing that by want of care the vent hole of a cell became clogged up and it exploded, under what Act can damages be claimed. Is it under the Explosives Act?

In conclusion, I must remark that out of the 38 cells sent here for special trial 2 were defective.

One who has Worked in KHO Solution.

Electrical Contractors and Manufacturers.

Your last week's issue contains a lengthy letter from Mr. Rashleigh Phipps, but it is quite evident from its contents that he is anxious to draw away from the subject under discussion.

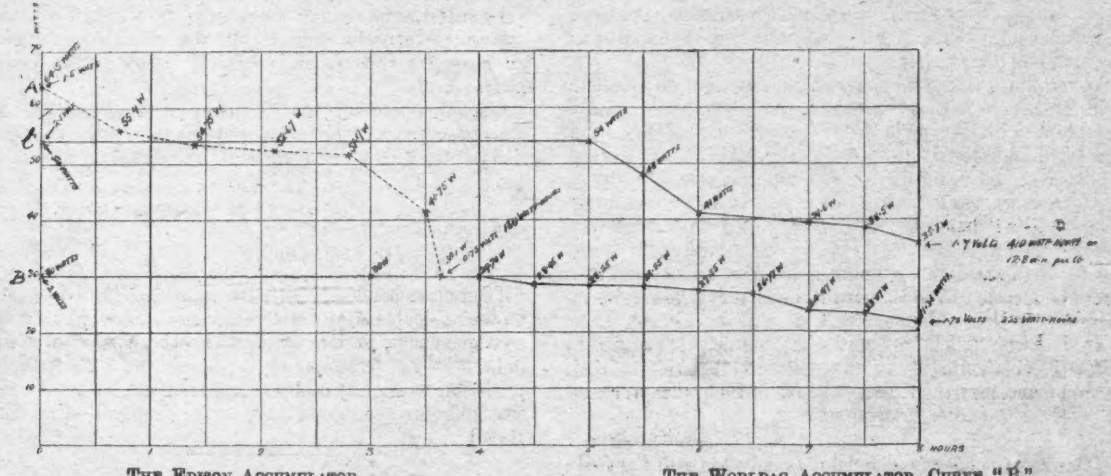
We raised objection to his letter to us dated 7th inst., the text of which you were good enough to publish in your issue dated 11th inst., and he does not offer a word in justification of the remarkable contents of this letter, or attempt to prove that we are wrong in our opinion that it is an attempt to gain members to the Association, and also an attempt at coercion. As we were only dealing with this letter, and not with the objects of the Association, it was not necessary for us to obtain particulars, as he suggests, before replying. We rather like the words "friendly action to suggest to several firms of manufacturers with whom we had dealings," &c.

We appear to have been in error in assuming that the National Electrical Contractors' Association and the National Electrical Manufacturers' Association were, to some extent, one and the same body. We learn that they are absolutely distinct organisations, although one would be weak without the other, and their agreement joins them together; this disposes of one of Mr. Phipps' bristles.

We made a mistake in assuming that Mr. Phipps was in any way responsible for the formation of the National Electrical Contractors' Association; we did not say that he was, we merely stated that we were under this impression, but it appears that he is only a past president, so this disposes of bristle No. 2, and we do not find any more.

Just after we "rushed into print" we received a letter from Mr. Davenport, enclosing a copy of the agreement between the two associations. The copy is marked "confidential," so we refrain from making any extracts from it, we only venture to remark that, speaking broadly, a moderate policy might have been more worthy of success; why not a preferential arrangement between members of the two associations, instead of a boycott against manufacturers not in the association? It might then obtain some sort of footing. The present scheme is likely to be unworkable, as contractors must buy in the most favourable market, of course, taking quality into consideration when the opportunity happily occurs.

Still, we are not writing to show our hostility to the associations; we distinctly stated in our letter to Messrs. Phipps



THE EDISON ACCUMULATOR.

Discharge in run on September 9th, 1903. Battery of 38 cells made especially for traction tests. The discharge was at 42 amperes rate for 8½ hours. The weight of the cell is given at 17·8 lbs. The total capacity = 150 watt-hours, or 11·2 watt-hours per lb. The curve No. 8 was given as representing the fall of potential, and from this the energy, curve "A," is calculated.

THE WORLDAC ACCUMULATOR, CURVE "B."

Official discharge made by the chief engineer of the Southend-on-Sea Corporation Works, as described in ELECTRICAL REVIEW, September 4th, 1903. Five plates were taken from the above battery after it had done over 800 discharges on traction and lighting loads, with an average efficiency of 92 per cent. in power. The plates for this battery were made specially strong to meet the 10 years' maintenance, and therefore we give also the curve "C," which was a discharge made by Prof. Hospitalier, of the Municipal School of Electricity and Chemistry of Paris, as described in the ELECTRICAL REVIEW, April 14th, 1899. Traction cell 11 plates. Weight, complete with acid, 32 lbs.

that we might be in sympathy with some of their objects, we undoubtedly are now that we have seen their agreement.

Of course it was by a mere coincidence that Mr. Davenport's letter, which accompanied his copy of agreement, should have been marked "sent you by request;" we did not ask him to send it, only it closely followed Mr. Phipps's letter, just allowing us time to "rush into print" before it arrived.

Ernest F. Moy, Ltd.,
E. F. Moy, *Managing Director.*

Camden Town, N.W.,
December 19th, 1903.

The Electrical Manufacturers' and Contractors' Agreement.

We have much pleasure in handing you herewith a digest of the agreement between the National Electrical Contractors' Association and the National Electrical Manufacturers' Association, and shall be much obliged by your inserting the same in your next issue.

Thos. Guthrie, *Secretary.*
National Electrical Contractors' Association,

Walter Davenport, *Secretary.*
National Electrical Manufacturers' Association.

London, S.E., *December 21st*, 1903.

Particulars of agreement between the National Electrical Contractors' Association and the National Electrical Manufacturers' Association:—

The contractors are composed of a number of firms carrying on business as electrical contractors in Great Britain and Ireland, who have associated themselves together for the purpose of protecting and advancing the character, status and interests of electrical contractors in Great Britain and Ireland, and the manufacturers are composed of a number of manufacturing firms, who have associated themselves together with a view of protecting and advancing the character, status and interests of electrical manufacturers and supply houses in Great Britain and Ireland.

At a joint meeting of both Associations an agreement was entered into, of which the following are the principal points:—

The contractors and manufacturers will not allow trade discounts to architects, consulting engineers, and other persons or firms who cannot fairly be considered entitled to be electrical contractors, wholesale factors or a trade house.

It is also provided that members of the said Contractors' Association will confine their dealings to the members of the Manufacturers' Association, and the latter Association agree to give the members of the Contractors' Association an exclusive bonus for this benefit.

The manufacturers agree not to give trade discount or terms to any but a trade buyer. Businesses having their own electrical engineering or electrical trading department under the supervision of a qualified electrical engineer are to be considered as a trade house, also all goods for shipment delivered direct to the docks shall likewise come under the heading of trade buying.

Exceptions are made in the case of railway companies, Government Departments and others requiring goods by public tender who will be entitled to trade privileges.

The agreement made between the two Associations will become operative from January 1st, 1904, and an Arbitration Committee, consisting of four members from each Association, has been elected to deal with questions arising out of the agreement, and with matters of general interest. The Committee consists of the following members:—

For the Contractors' Association:—
(*a*) E. L. Berry (E. L. Berry, Harrison & Co., London), President, London Electrical Contractors' Association.
(*b*) J. McDermott (Lancashire Electrical Engineering Co., Ltd., Ashton-under-Lyne).
(*c*) A. Rashleigh Phipps (Rashleigh Phipps & Co., London).
(*d*) W. R. Rawlings (Rawlings Bros., Ltd., London), President, National Contractors' Association.

For the Manufacturers' Association:—
(*a*) H. Bevis (General Electric Co., Ltd., London).
(*b*) C. S. Northcote (Veritys, Ltd., London).
(*c*) H. Oppenheimer (International Electric Co., London).
(*d*) S. Paterson (Johnson & Phillips, London).

In addition to the Committee, Mr. Tweedy Smith, of Messrs. Turner & Co., solicitors, has been appointed umpire to act in case of any dispute arising under the agreement.

Mr. Thos. Guthrie, 46, Queen Victoria Street, London, E.C., is secretary to the National Electrical Contractors' Association; and Mr. Walter Davenport, Ridler Place, Holland Street, Blackfriars, London, S.E., is secretary of the National Electrical Manufacturers' Association.

"E. H. W.," Bridgend.—Your name and address were omitted from your letter. We may say, however, that the subject of wood casing *versus* steel tubing has been so often and so fully discussed in our pages that we cannot at present spare space for a renewal of the controversy. It is unwise to say that any system is universally "the best"; so much depends upon circumstances.—Eds. Elec. Rev.

Name of Maker Wanted.—A correspondent wants to know the name and address of the makers of the "Clarke" intercommunication telephone sets.

THE STRIKE CLAUSE.

Like all who have to do with works the execution of which extends over a long period of time, electrical contractors are deeply interested in what is known as the "strike clause," which is inserted in every contract of any magnitude. In former days the absence of such a clause was frequently used by trade union organisers as a lever wherewith to bring employers to their knees when disputes arose with workmen; the result of a strike clause is to shift the burden of responsibility from the contractors who are under agreement to do the work to those who employ them to do it.

The strike clause has recently come before the Courts in the case of *re* An Arbitration between Allison & Co. and Rose Richards, which was heard by Mr. Justice Wright on November 5th. In that case an important question relating to the allowance or disallowance of "holidays" as lay days was decided. It appears that on April 1st, 1903, the plaintiffs entered into a charter party to carry a cargo of coal on their steamship to Leghorn. The charter party contained a clause providing as follows:—

"The cargo to be loaded in 130 running hours (excluding . . . Sundays, Custom House, colliery, and local holidays, Easter Monday and Tuesday, Whit Monday and Tuesday)." And further:—"Any time lost through riots, strikes, lock-outs, or any dispute between masters and men occasioning a stoppage of pitmen, trimmers, or other hands connected with the working or delivery of the coal for which the steamer is stemmed; or by reason of accidents to mines or machinery, obstructions on the railway or in the docks, or by reason of floods, frosts, fogs, storms, or any cause beyond the control of the charterers, not to be computed as part of the loading time."

The colliers belonging to the colliery from which the coal was taken gave notice that they would work on Good Friday and the next day, but that they would take the Wednesday after Easter Monday, and on that day all work was stopped. It was contended on the part of the plaintiffs that demurrage was payable in respect of the Wednesday upon which the men refused to work, inasmuch as it was not a "holiday" within the meaning of that term, as used in the charter party. Further, it could not be said to be a stoppage caused by a strike, as there was no dispute with the masters, who had done nothing either by way of approval or disapproval. It was argued on the other side that although this Wednesday may not have been a "holiday" within the meaning of the charter party, yet the stoppage on that day was a stoppage *ejusdem generis* with loss of time caused by strikes, lock-outs, &c. Mr. Justice Wright gave judgment for the defendants. He said: "This was a holiday not within the control of the masters, and was, therefore, not within the exception contained in the charter party. . . . I am inclined to think, however, that a holiday taken by the men without the concurrence of the masters, is sufficiently *ejusdem generis* with stoppage of work caused by a dispute between masters and men, and perhaps of strikes, and therefore within the exception."

A glance at the above decision shows that it is of far reaching importance, for it involves a very considerable extension of the operation of the well-known "strike clauses," which is of such vital interest to employers of labour. As is well known, the strike clause takes it out of the power of workmen to dictate terms to their masters, as it prevents actions being brought against contractors who are unable to fulfil their contracts to time owing to labour troubles. In declaring that a "holiday" taken arbitrarily by the men is a stoppage *ejusdem generis* with a strike, Mr. Justice Wright has still further increased the value of the clause. A concrete example may serve to illustrate our meaning. The famous "stop-day" case, which involved a large number of colliery owners in South Wales in litigation with the South Wales Miners' Federation, arose out of the declaration of certain stop days by the officials of the Union. The stop days resulted in enormous loss to the coalowners, and it is probable that some of this loss was attributable to the fact that time contracts were broken. It may be, of course, that the companies were protected by

special clauses which included "stop days"; but if they were merely protected by clauses similar to that before Mr. Justice Wright, the learned judge's recent interpretation would have excused them from all liability. As to the effect of this decision, it is certainly of the greatest advantage to employers. Ship owners, however, will probably not look upon it with so much favour.

LITIGATION OR COMPROMISE?

[FROM A LEGAL CONTRIBUTOR.]

THE opening of an electric tramway to the public very naturally gives rise to speculation upon, and attempted answers to, the question, Will it pay? The average man is convinced that this momentous question can be answered by reference to a few figures. He ascertains the cost of construction, and makes this a basis for estimating the capital value of the undertaking. He next looks at the prospective gross annual income, and, after making due allowance for cost of working, depreciation, and so forth, he simply considers whether the net income is sufficient to pay a proper dividend upon the capital which has been laid out; and after these investigations he considers himself in a position to pronounce judgment. To him the computation is a mere matter of account.

But the matter is presented in a very different light to those who have to keep down working expenses as much as possible. Under the head of working expenses there are many outgoings which increase as the mileage is increased, and the amount of which can be safely estimated for years ahead. But there is one item of expenditure under the head of "working expenses" which is not by any means capable of easy computation, and which is always a source of trouble to those who are responsible at once for the continuous and punctual running of the cars and the safety of the wayfaring public. We refer to the "item"—indeed, it were better described as a multitude of items—"payment of compensation for accidents." The company or local authority which runs electric cars is in a singularly unfortunate position with regard to claims for damages for personal injuries. Let us consider its position for a moment. It is true it has a virtual monopoly of the passenger traffic along the streets.

This monopoly has been granted on terms, the onerous nature of which is too often lost sight of. Thus the owners of a tramway are bound to convey passengers at absurdly low rates; they are bound to keep their cars running practically at all times and in all weathers; they have imposed upon them the duty of repairing and keeping in repair the surface of all that part of the highway which is covered by their lines; and, if they are private undertakers (as distinguished from local authorities), they are bound after the lapse of a certain number of years to sell their entire undertaking to the local authority, if the local authority so requires.

It would, of course, be absurd to suggest that tramway undertakers should be exempted from responsibility for accidents, which too often arise through the negligence of their drivers and conductors. To acknowledge any such principle would be to grossly interfere with the rights of the public, who are entitled to be protected in their use of the streets. Nor would it be right to relieve the tramway undertakers from responsibility, even if they prove that they took every precaution in the selection of competent drivers and conductors. That would be a violation of the well-known principle of English law, which is embodied in the maxim, "*Respondeat superior*." But it is a patent fact that every wealthy corporation is in a singularly unenviable position when it appears as defendant to an action for damages for personal injuries. Moreover, the driver of every car is always between Scylla and Charybdis. If he drives at too great a speed he increases the risk of accident. If, on the other hand, he displays too much caution, his delay occasions inconvenience to the public; for the pace of the cars on the route is to all intents and purposes the pace of the slowest.

It may safely be asserted that in nine out of every ten cases where a tramway company is brought into Court as defendant in a "running-down" case, it comes off second best. There are many influences which conspire together to this end. In the first place, what is the tribunal? If the case is heard before a jury in the County Court, the jurors are probably selected from amongst the tradesmen who carry on business in the district where the cars run. As a rule persons of this class have no bias in favour of a company whose passing trams interfere with their rights as frontagers, and hamper the movements of their collecting vans. If the claim is of larger proportions, the case is brought in the High Court, where similar influences may have their effect. But there is yet another influence of enormous importance constantly at work upon the minds of every juror. The plaintiff is often a poor man who has even found it difficult to find the funds with which to initiate proceedings. In many cases, indeed (but tell it not in legal circles!), the litigation is conducted on the "no cure no pay" system. The defendants, on the other hand, are a wealthy corporation who, from the jury's point of view, can easily afford the payment of a small sum by way of damages.

It is almost idle to attempt to discount the effect of such an *argumentum ad hominem*, which, although it cannot be made use of by counsel for the plaintiff, is ever present to the minds of the jury.

This leads us to the discussion of a question which is always vexing those who are responsible for keeping down the working expenses of an electric tramway, namely, whether it is more economical to fight every case out to the bitter end, or to compromise all claims. It is obvious that there is much to be said on both sides. The prospect of a hard fight in Court; the uncertainty of the issue; the certainty that there will be great delay; the certainty that, whoever may ultimately win the cause, the lawyers on both sides must make their profit; the danger of adopting a principle of compromising every claim, and, by so doing, encouraging fictitious claims, are all matters which would seem to justify a defiant attitude on the part of the company. On the other hand, the compromise of every claim is not nearly so expensive as might be imagined. The prompt payment of a small sum in hard cash is more acceptable to many people than the prospect of a judgment against the company at some time in the distant future. By making a reasonable offer, and tendering the amount of the offer before action is brought, and paying it into Court, the company is relieved from paying the plaintiff's costs if the sum awarded by the jury is less than that which has been paid in. Again, from the company's point of view, the settlement of every claim out of Court saves a large amount in costs, for, even in cases where the company is successful, the costs are seldom paid by the defendant, who is frequently a man of straw.

The foregoing arguments will have shown that the question is really an actuarial one. Which policy is the most economical in the long run? We are given to understand that interesting experiments have been tried in order to ascertain which of the two courses is most economical. Thus one of the London 'bus companies contested all claims made against it in one year, and compromised them all in the next. It was found that compromise proved most economical.

PHYSICAL SOCIETY.

PROCEEDINGS AT THE MEETING HELD DECEMBER 11TH, 1903.

Mr. JAMES SWINBURNE, Vice-President, in the chair.

A PAPER on "A Method of Mechanically Reinforcing Sounds" was read by the Rev. T. C. PORTER. If a tuning fork be sounded and placed in a flame, there is a very marked reinforcement of the sound, due to the change from continuous to intermittent combustion. Thus a new way of reinforcing the sounds given by a vibrating body is found; and the paper demonstrates this for the phonograph, a flame being used instead of the ordinary trumpet.

A paper on "The Simmance-Abady 'Flicker' Photometer," by Messrs. Simmance and Abady, was read by Mr. SIMMANCE. The authors, guided by the following rules, have designed a photometer which is capable of balancing and comparing the most violently

contrasted tints:—The light effects must be in juxtaposition without any apparent division line, and must move, oscillate, or rotate so that the point of juncture of the rays of the two lights passes and returns entirely across the vision field. Any hiatus, or longer exhibition of one light than the other, biasses the result. The observation surfaces, or surfaces upon which the light rays fall, must be at exactly the same distance from the eye, at exactly the same angle in relation to the line of sight, and must be of pure white; any tint affects the accuracy of the result. The observation surfaces must also themselves in turn occupy the field of vision; an apparent movement or optical illusion does not afford accurate results.

Observations made with the photometer by operators suffering from colour blindness, astigmatism, &c, make it certain that the relative intensities of two lights, whether of the same colour or different, *can* be accurately and easily gauged by the method. The authors submit that the Purkinje phenomenon does not affect the accurate working of the instrument, as it is a purely colour effect, and colour does not enter into consideration in this photometer. The photometer itself consists of a wheel of a white material with a specially shaped periphery, which is caused to revolve before an eye-piece by means of a suitable motor. At right angles to the line of sight and parallel with the axis of the revolving wheel, are the two lights undergoing examination, the rays of which fall upon the shaped periphery of the wheel, enabling the effect of each light to be seen in turn through the eyepiece.

Prof. W. E. Ayrton said it was an important question to settle exactly what the photometer measured. The fact that different observers using the same photometer obtained the same results, for the ratio between two lights, did not prove that the instrument actually compared intensities. He had come to the conclusion that when the distances between the sources of light and the photometer were great, the results were not affected by the Purkinje effect.

Mr. T. C. Porter said there was no doubt that the flicker photometer measured intensity independent of colour. The results obtained directly from a flicker photometer agreed with those deduced by indirect methods from observations with ordinary instruments.

Mr. L. Gaster said that this type of photometer was becoming more important because of the great number of improvements made during the last few years in the manufacture of incandescent lamps and arc light carbons by the addition of other substances to the pure carbon. A great step towards the simplification of the process of photometry had been attained by Prof. C. P. Mathews, by the aid of whose photometer one is enabled to get in one reading, an illumination upon the screen, proportional to the mean spherical intensity of the source.

Dr. W. Watson said the authors had compared a red light with a white light and also a blue light with a white light. He asked if they had compared a red with a blue directly, and if so, how the results agreed with those deduced from the comparison of both with a white light.

Mr. W. Duddell asked what was meant by the equality of two lights of different colours. Was it judged by the eye, the bolometer, or the flicker effect? On account of the Purkinje effect the inverse square law could not be used, and he asked for the real fundamental relation underlying the use of the instrument.

Mr. J. Abady, replying on behalf of the authors, said the discussion had turned mainly on two points:—(1) Does the instrument measure candle-power? and (2) is it independent of the Purkinje effect? If a Bunsen disc were used to compare the candle-powers of two lights of the same colour, the grease spot vanished at a certain point. If a flicker photometer were substituted for the Bunsen disc, the flicker disappeared at the *same* point. In both cases candle-power had been measured. In reply to Prof. Ayrton he said that results obtained from the photometer by different observers agreed among themselves and also agreed with results obtained from the Bunsen disc photometer. With regard to the Purkinje effect, he did not think it affected the readings of a flicker photometer, because the same values for the ratio between the intensities of two different coloured lights were obtained by varying the distances of the lights from the instrument within wide limits. Answering Dr. Watson, they had carried out the experiments suggested, and the results from the direct and the indirect comparison were in absolute agreement.

Mr. Rollo Appleyard exhibited a "Conductometer," the theory and mechanical details of which are fully described in the *Proceedings of the Institution of Civil Engineers*, Vol. cliv., Session 1902-3, Part iv., and, in brief, in the Electrical Review of October 9th, 1903, pp. 601—603.

Prof. L. R. Wilberforce exhibited "a model to illustrate various properties of wave-motion." The model consists of a series of brass balls suspended in a line by spiral springs and capable of transverse or up and down motion.

ELECTRIC POWER APPLIANCES IN THE MINES OF EUROPE.

In two recent issues of the *Engineering Magazine* M. Emile Guarini contributes two very interesting articles on this subject, surveying in a general way the application of electricity in mining already established at collieries in European countries.

In comparing the progress of the adoption of electricity in different countries, M. Guarini says:—"Germany is far in the lead and German manufactures predominate," and gives the second place to Austria-Hungary, whilst of this country:—"England with its many mines would naturally be expected to show a large development of the use of electric appliances in mining. It does not, however, display the expansion in this direction one would anticipate." As has already been pointed out in the columns of this journal, this is due to the position and training of the colliery manager, and to some trouble experienced by work done on cut contracts and without efficient supervision. Not long ago, for instance, we saw a starting switch supplied for a coal-cutting machine, designed for a pressure of 500 volts, with the insulation of *wood*, and generally a more wretched thing never was seen. It went wrong, and no wonder! Electricity, however, is already established, and is becoming more extensively adopted every day.

In comparing the advantages of electricity over other systems, M. Guarini says:—"Steam, water under pressure, and compressed air, all require piping, and this is their chief drawback. The pipes are difficult to install, to maintain, and to keep tight. Their length and the attendant friction and leakage losses diminish the efficiency. Added to that, in the case of steam, is the moist heat of the mine which affects injuriously the health of the workers and the condition of the timbering," all of which is very true, but in adopting electricity it is very questionable if "Finally, the total number of employés may be considerably reduced." Though many Continental mines are electrically equipped, none, to the author's knowledge, is operated solely by electricity, which will be interesting to British engineers, who have had so much of German methods and manufactures dinned into their ears; and that though three-phase current appears to be much adopted, three of the largest manufacturing firms in Germany—presumably after some experience—"incline rather to the continuous current," and that "the voltage of the direct current should not exceed 1,000 volts; ordinarily it is not more than 500 to 550," and for three-phase "the primary tension usually employed is 2,000 volts, the secondary or service tension being 500 volts;" and M. Guarini himself agrees with what has already been said in these columns, as to there being no advantage in adopting three-phase plant except where the distance of transmission is great.

With reference to motors, M. Guarini says:—"A common difficulty in the use of electric motors for driving mining machinery is that their speed is not suited to the work in hand; the simplest, if not the best, means of overcoming it has been the use of gearing. . . . . The objections to this are the loss of efficiency, the space required, and the chance of breakage in the gearing, not serious, perhaps, with a small machine, but possibly a grave matter with a large one. For this reason preference is often given to belts." This is very questionable, and—at least in this country—well-designed gearing very seldom breaks; in colliery work gearing is very extensively used, but the breakages are an infinitesimal proportion, and, with well-designed machine-cut gears, or machine-moulded ones for the larger sizes, the efficiency loss is reduced to a minimum. Gearing is to be preferred to belting, which requires considerably more space, and consequent expense in buildings or excavations, as the case may be. Each, however, has its special advantages, according to circumstances.

If one is to judge from the description given of the lighting of the Gottessegen Mine, at Zwick, we are far ahead in this country in the magnitude of electric lighting installations at collieries; miners' portable lamps have been used for some years, but are not generally adopted, as they give no indication of the state of the atmosphere, and it is possible for a miner to be overcome with foul air before noticing that anything is wrong, whereas an ordinary oil safety lamp would not burn, or would at once give an indication of the presence of gas. As to electric signalling and telephonic communication, this has been a feature in English mines for many years past, and the German systems described are no improvement—unless complication can be called an improvement—upon English methods.

With regard to pumping, M. Guarini says:—"The direct operation of mine drainage pumps is one of the most troublesome problems the electrical engineer has had to solve, on account of the very high speed of the electric motor, and the very slow speed of the pump. Builders of motors and of pumps have approached each other by a series of concessions, the former slowing down and the latter speeding up their respective machines. From this has resulted the so-called "Express pumps" made by many firms—among other builders on the Continent, by Ehrhardt and Sehmer, the Maschinenbau Anstalt, of Breslau, Riedler & Stumpf, Hope, of Berlin, and Jandir, of Lyons. The pumps of Ehrhardt & Sehmer are specialised by their mechanical construction. The plungers are single-acting, the valves vertical-lift and superposed. The valve-seats are held by lateral studs; the plungers are worked directly by the rod. There is, however, nothing in this—with the exception, perhaps, of the Riedler pump with its mechanically-worked valves—that is superior or much different to English practice, and possibly for mining work no pump is more suitable than a simple three-throw ram pump. A colliery depends upon the water *being kept out* more than on the cost of the operation, and the "Express" pumps will not use less power or keep the water out better, but being much more complicated, will possibly add to the expense and trouble. Their only advantage is that perhaps a little less space is occupied. In view of what has already been said on three-phase current, it is interesting to note that the three large pumping plants described or illustrated by M. Guarini are all worked by three-phase motors with voltages of 2,200 or 2,300 and a frequency of 110 periods per second, and 970 volts and 20 periods.

From the little that is said about coal-cutting, it would appear that this operation is much more advanced in this country than on the Continent.

One or two electric locomotives are described, but it is an open question whether there is any real advantage in underground loco-

motives, and probably they will never be adopted to any extent in this country.

As to "winding," M. Guarini says:—"Less progress is to be noted, however, in the adaptation of electric driving to the operation of mine hoisting engines, on account of the difficulties presented by this particular work. These lie in the coupling of the motor to the winding drum and in the regulation of the speed. Direct coupling requires that the speed of the motor and the diameter of the drum shall both be reduced. Speed regulation is effected in various ways. With direct current, use may be made, for example, of two motors, each of half the requisite power. Connection in series or in parallel gives half or full speed. The Allgemeine Elektricitäts Gesellschaft make use of a liquid rheostat, the liquid reaching an overflow when the motor attains its full speed." "Starting, speed regulation, and stopping have also been controlled by varying the excitation of the dynamo. Finally, resistances have been employed to the same effect, though not to very good advantage. *Constructors have, therefore, given much attention to safety appliances, and hoisting machinery is generally well equipped with many safeguards*—powerful brakes operated by hand, by foot, by compressed air, or automatically if the cage passes the upper landing. The automatic brake acts by cutting off the current. Another automatic device, on the other hand, comes into play if, for any cause, the circuit is unintentionally broken. In such case a powerful electro-magnet is demagnetised and lets fall a weight which operates the brake." (The italics are ours.) Two illustrations show what appears to be a very complicated—compared to English practice—winding apparatus. Now the output of a colliery depends upon the winding engine, and, moreover, this is generally the means by which the underground workmen reach their destination and return. Winding is therefore the most important operation of the colliery, and the machinery is to be designed to be absolutely safe, and, at the same time, rapid in motion. The size of winding rope controls to a great extent the size of the drums, and therefore, if motors are to be coupled direct, the drum can only be reduced at the expense of the rope. In England, safety appliances, with the exception of an overwinding apparatus, which is compulsory, are not much in vogue, and the prevention of accidents is relied upon by careful examinations, attention, and at many collieries limiting the life of the ropes. The engines are as simple as possible; it is questionable even if much economy results from a complicated valve-gear, owing to the intermittent, quick starting and stopping action, and certainly no British mining engineer would remove his simple steam winding engine and replace it with a system of complicated connections and a variety of safety appliances. M. Guarini says:—"It is stated, indeed, that at the Heinrichschacht the adoption of electric hoisting effected an economy of *one-third in the fuel alone*, to take no account of the saving in wear and tear or in lubricants."

In concluding, M. Guarini cites two cases showing the economy resulting from the adoption of electricity, which are useful and interesting:—"Prior to the introduction of electricity, the Burma Ruby Mines were unable to make any dividends, the expense of operation being too high. Since its adoption the expenses have been reduced by the sum of £6,000 per annum, permitting the payment of profits; and at the Sheba Mine the economy in operating expenses since the introduction of electric power in 1896 has amounted to £10,000 per annum," which should be noted by colliery managers.

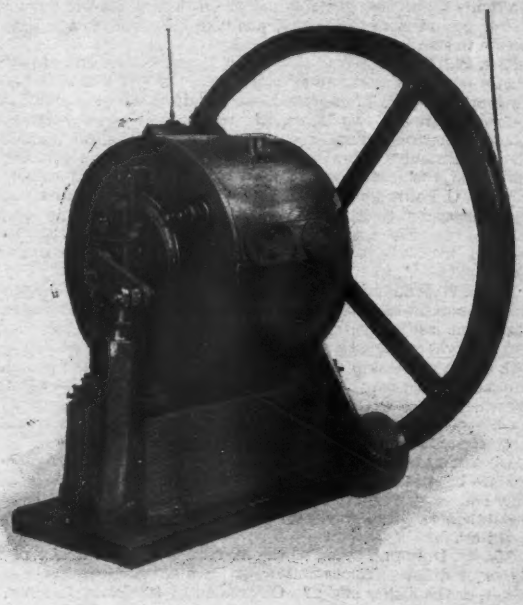
Generally the articles tend to show that in England we are not behind our Continental neighbours in the application of electricity to mines, but that rather the tendency has been to apply it to those operations where its advantages and certain economy were evident; and such questions of winding and pumping can only be settled by circumstances which in England have not as yet justified their general adoption.

BUSINESS NOTES.

The Parsons Steam Turbine in America.—We are informed that the American Westinghouse Co. has acquired the full rights to manufacture the Parsons steam turbine in the United States and Canada for all purposes, including that of marine propulsion. A special department is being organised at Pittsburg for building this type of engine for vessels of every class, including warships, and this work will be carried on in close touch with the shipbuilders all over the country. Engines as large as 8,000 H.P. are already being built at Pittsburg, and the Westinghouse Co. looks forward to immense developments in this new branch of industry, more especially with regard to ship work.

Runcorn and Widnes Transporter Bridge.—The trolley of the Runcorn and Widnes transporter bridge, now in course of erection, will be about 77 ft. long by 100 ft. across from side to side. There will be 16 track wheels on each side, and the car, capable of accommodating four two-horse wagons and 300 people, will be suspended from the trolley by steel wire ropes. To enable the trolleys to be brought to rest rapidly, in spite of the great momentum of the moving mass, Westinghouse magnetic brake equipments will be fitted to the wheels of the truck, the equipments being modified to suit the special requirements. We learn that a large further order for these brakes has been placed by the Leeds Corporation with the British Westinghouse Co.

New Automatic Liquid Switch for Intermittent Work.—We illustrate herewith a new type of switch for periodically starting and stopping motors connected with pumping machinery, organ-blowing and the like. From the description given below, it apparently fulfils a long-felt want for a really good automatic switch which is positive in its action, and requires little or no attention. The action of this switch if, say, used for pumping out a tank or well is as follows:—The float, which is attached to the end of the cord, rises and falls with the level of the liquid in the tank, there being a balance weight on the other end of the cord. As the float rises it rotates the wheel of the switch by means of the cord until it has almost reached the level at which the pump is required to start; it will then have brought the weighted lever to the vertical position. A slight movement will then cause the lever to overbalance and fall against a projecting lug on the rotatable cast-iron containing vessel, causing this to rotate slowly against the action of an improved type of dash-pot. As the liquid in the switch vessel always remains at the same level the rotation of the vessel will cause the internal blades to dip gradually into the liquid, thus cutting out the resistance and starting up the motor. The switch is then automatically short-circuited for the running position, the blades and



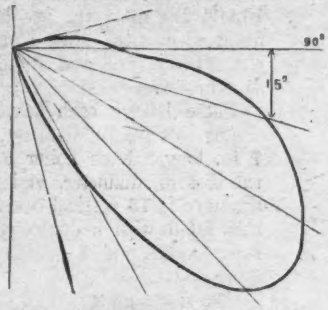
New Automatic Liquid Switch.

liquid being entirely cut out of circuit. The reverse action takes place when the water falls to any desired level. The chief point the makers claim is reliability of action, there being no multiple contacts to become roughened by the minute sparking which is inherent in all wired contact switches, causing sticking of the switch and burn-outs. The cord being mechanically attached to a point on the insulated wheel, any flexible metal cord can be used without tappets, which have the fault of occasionally slipping. By means of a movable segment on the wheel side of the switch the starting and stopping point can be adjusted to any water level. If for any reason, which is highly improble, the switch should stick, there can be no burn out, the most that would happen being the evaporation of the electrolyte and the consequent stopping of the motor. The field is made and broken each time the motor is started and stopped, so that there is no waste of power. From the sliding contact to the "full-on" or short-circuiting position, the difference of resistance is so small that there is no jump or spark whatever. This switch is being manufactured by the Sandycroft Foundry Co., Ltd., Chester, who also manufacture liquid continuous-current automatic starters equipped with overload and no-voltage releases, reversing controllers, polyphase starters, theatre dimmers, &c., under the Woolliscroft patents. The standard types of Woolliscroft liquid switches having been a marked success, there can be no doubt that this new automatic switch will be welcomed by many users who have experienced trouble in the past with wire resistances used for this special service.

Westinghouse Contracts.—The British Westinghouse Co. is supplying two 80-H.P. motors with starting gear, to Messrs. Merryweather & Sons, for fitting to fire pumps. These will eventually form part of the extensive gas-driven generating and electric lighting and power plant which the Westinghouse Co. are erecting at Heysham Harbour for the Midland Railway. The company is also supplying a 45-KW. continuous-current dynamo, for direct connection to a Westinghouse gas engine, to Messrs. B. Napier & Son, of the Motor-Car Works, Acton Vale, W.

E.C.C. Hospital Fund.—The employés of the Electric Construction Co., Bushbury, near Wolverhampton, held their annual meeting at the works institute last week for the purpose of allocating their hospital fund. The total for distribution was £195.

G.E.C.-British-made Carbons.—As our readers are aware, the General Electric Co., Ltd., is at present making heroic efforts to reclaim the arc lamp carbon industry, which, though first introduced in this country many years ago, has passed largely into the hands of Continental manufacturers. The difficulty has been to produce an article in England which should compete successfully with the carbons turned out by foreign firms. This the General Electric Co. has succeeded in doing, and it is to-day producing arc lamp carbons of the high-class quality at its Witton works, which, both in point of quality and general efficiency, are claimed to be at least the equal of the carbons of any of the leading Continental makers. This firm has caused tests to be carried out quite recently on five 10-ampere "Angold" arc lamps, running in series, fitted with the firm's "Apostle" carbons, of which the following were the dimensions 18 mm. × 12 in. long, cored, 120 mm. × 12 in. long, solid, the weight of a pair being 162 grammes. The average line pressure was 238 volts, and allowing a drop of 23 volts in the steadying resistance, the average pressure across the lamps was 215 volts, or 43 volts per lamp. An average current of 10 amperes was used. The tests lasted



PHOTOMETRIC TEST OF
THE BIRMINGHAM CARBON WORKS.
ENGLISH MADE CARBONS.
18"/m Cored Positive
12"/m Solid Negative.
Current 10 Amp.
Arc E.M.F. 42 Volts.
SCALE
0 100 300 500 Candles.

20½ hours, and the average rate of consumption of the carbons per hour was 505 in., or 1·282 cm. for the cored, and 451 in. or 1·146 cm. for the solid. The first lamp gave an ash residue of 3·7 grammes, the second the same, the third was open, the fourth gave 3·2 grammes, and the fifth 4·0 grammes. Thus the average ash of the four lamps with globes was only 3·65 grammes, or 2·25 per cent. The total volume of ash from the four lamps was 22·6 cc. and the rate of the volume of the ash to the weight of the ash equally $\frac{1{\cdot}54}{1}$. The carbons started up without flaring, with full pressure across the five lamps, and normal resistance in circuit. They continued to burn absolutely steady during the whole time of testing, while the formation of the arc was normal. The above satisfactory results, it will be observed, were obtained under ordinary working conditions, and are in no way exceptional for "Apostle" carbons.

We may also give the results of a successful photometric test of the company's carbons, carried out by the Electrical Standardising, Testing, and Training Institution. The sizes of the carbons used were the same as in the tests above described. The voltage across the arc was maintained at 42 volts, to a current consumption of 10 amperes. The test showed that the maximum light ray occurred at an angle of about 38° from the horizontal, when it was of the value of 1,820 c.p. At 50° the candle-power was still 1,500, and the same at 20°; thus, over an angle of 30° there was only a fall of 323 candles, or 16 per cent. of the maximum candle-power obtained. If we take the results of this test and apply them to the figures obtained in the previous tests, we find that the consumption of current expressed in watts per maximum candle-power is only 0·24—a remarkably low record.

The above figures are held to be conclusive of the high efficiency of the Witton-made carbons, and of the economical results that may be obtained with them.

Forthcoming Book.—A new engineering work is announced by the Caxton Publishing Co. It is called "Modern Engines and Power Generators," and is to be a thoroughly practical work on the design and construction of prime movers and the transmission of power by steam, electricity, water and air. The author is Mr. Rankin Kennedy.

Insulating Compound.—Messrs. Rowland Carr & Co. have again secured the annual contract for the supply of insulating compound for the National Telephone Co.

Catalogues and Calendars.—Messrs. R. W. Blackwell & Co., Ltd., have just issued a new catalogue of their various copper rail bonds of the "Chicago," "Crown," and "Solid Terminal" patent types, of which they have supplied such large numbers for electric tramway systems all over the world.

From Messrs. E. Reader & Sons, Ltd., of 5, New London Street, E.C., we have received an illustrated catalogue of their high-speed vertical and horizontal engines for dynamo driving and other purposes.

The Electrical Co., Ltd., are introducing to the market the Rignon continuous-current arc lamp. The arc is enclosed, and one pair of carbons will burn for about 15 hours. Specially prepared carbons of very small diameter (4·2 mm.) are used, and by this means a 200-c.p. light is obtained with a current consumption of only two amperes. The lamp may be built singly on a 100 to 110-volt circuit, or two in series on a 200 to 220-volt circuit, a small steadying resistance being used. It is claimed that the current consumption of the lamp, including resistance losses, does not exceed from 1 to 1·1 watts per c.p., and, as the special carbons used in this lamp leave very little ash, the globes are said to practically retain their original transparency. A further advantage claimed is that violet colouring of the arc has been almost entirely done away with. The stump of the upper carbon is used as a lower carbon, and in this way the greatest economy in carbon consumption is obtained.

Messrs. Crompton & Co., Ltd., have issued several new circulars of some of their lines, *i.e.*, arc lamps, electrical measuring instruments, enclosed ventilated c.c. motors, and ceiling fans.

The Power Plant Co., Ltd., of 20, New Bridge Street, E.C., have issued a number of leaflets describing their portable two-stage one-cylinder compressors for electric drive, the "Globa" patent worm gear with roller wheel, and a new electrical hand-drilling machine with three speeds. Others, to be issued later on, will deal with suction power gas plants, double-helical wheels and valveless pumps. Dr. B. Wiesengrund is the company's managing director, and Messrs. Tyler and Duncan are directors.

The Linolite Co., of 47, Victoria Street, S.W., has lately brought out a second edition of its 16 pp. pamphlet, describing the Line o' Light system of electrical illumination. It will be remembered that particulars of this very effective system were given in our columns some time ago.

Messrs. Dorman & Smith, of Salford, have placed before us advance copies of the pocket edition of their price list of switches, ceiling roses and numerous electric light fittings and accessories. In addition to the short list of some of their stock lines, there have been included 16 pages of general information, which should be more or less useful to electrical contractors and engineers, and also 64 pages of memorandum paper for the purposes of notes, &c. Its object is to place before clients and friends a selection of the prices of important lines more conveniently than can be done with the firm's large catalogue.

The Simplex Steel Conduit Co., Ltd., has favoured its friends with a neat and handy pocket diary for 1904. The left-hand pages are for engagement entries, the right-hand pages which have a cut index being arranged for an alphabetical list of addresses. In addition there is the usual calendar information, and a £1,000 accident insurance coupon.

We welcome once more the very serviceable desk pad of the Electrical Power Storage Co. It has, as usual, the useful memoranda diary, and is one of the best ways we know of for keeping the E.P.S. battery under the eye of the commercial and central station engineer.

The latest pamphlets issued by the B.T.H. Co., to form part of their well-known series are:—No. 162, devoted to automatic circuit-breakers; No. 79, giving prices of electrical measuring instruments; and a supplement to No. 155, giving dimensions and weights of B.T.H. induction motors.

Messrs. Neville Bros., of 7 and 9, James Street, Liverpool, have sent us a set of lists of their various machines for electrical manufacturing work. They include descriptions and large illustrations of slot broaching and slitting machines for assembled stator and rotor stampings of induction motors, armature disc varnishing machines, automatic feed coil winders, wire-winding machines for arc lamp and telephone coils, rotary shears for armature discs and rings, radial drills, milling machines, portable cranes, &c.

Messrs. Tangyes, Ltd., of Birmingham, have just issued their No. 60 steam engine catalogue in which very full particulars of their single cylinder and compound horizontal and vertical engines are given. It abounds in beautiful illustrations of the firm's many types of engine for various classes of work, several of them representing examples for electric lighting installations on board White Star liners and other ships. A price list of their "unrevised machinery" at present in stock has also been received.

Messrs. Cox-Walkers, of Darlington, have issued a wall show-sheet, upon which appear views of a switchboard provided by them for the Royal Masonic Schools, Bushey, Herts, and the plant installed by them at the Kesteven County Asylum, Lincolnshire.

Messrs. W. F. Dennis & Co., of 49, Queen Victoria Street, E.C., have brought out a new catalogue of their "Neptune" copper rail bonds for electric tramways and railways. Prices and illustrations are given of various solid and flexible bonds, cross bonds, &c. Several cuts show a few methods of bonding rails, and there is a view of the "Neptune" bond tool for effectively expanding solid bonds, so as to make a good contact with the rail.

A list of carbon resistances is being circulated by Messrs. Ernest F. Moy, Ltd.

Some handy and very acceptable little aluminium ash-trays, received from the Edison and Swan United Electric Light Co., will ever keep the Royal Ediswan incandescent lamp before our mind's eye.

Exports of British Electrical Machinery.—November proved to be the quietest month of the year as regards the exportation of British electrical machinery, the returns showing a total of only £23,889, as against £38,459 in October last. For the 11 months ending with November, the aggregate shipments have amounted to £394,170.

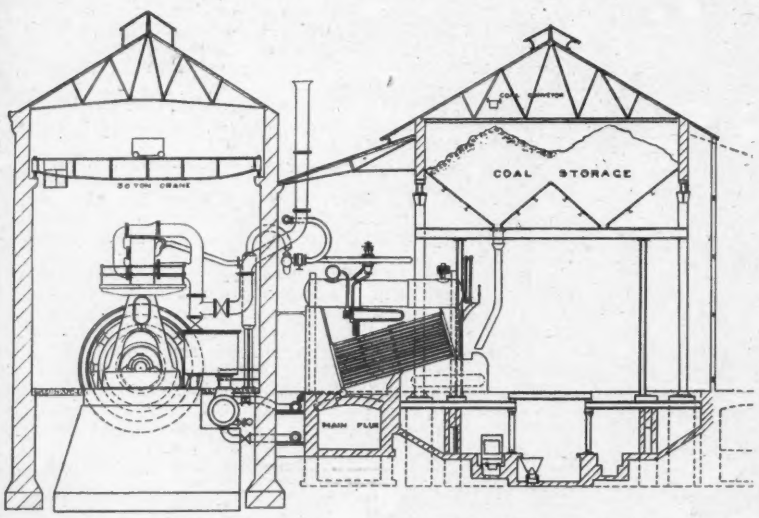
Belgium.—Le Compagnie Belge d'Electricité Siemens-Schuckert is the name of a company which has just been formed in Brussels with a capital of £20,000.

(*Continued on page* 1035.)

RECENT EXTENSIONS OF THE BRADFORD CORPORATION ELECTRICAL UNDERTAKINGS.

(*Concluded from page* 993.)

IN the year 1900 it was seen that, despite the considerable extensions to the Valley Road (No. 2) station, the plant there installed would be inadequate to meet the increased demands which would shortly be made upon it, for supplying the Corporation's extended system of electric tramways. The E.L. Committee, therefore, decided to erect a third station, which would contain larger units than was possible in the older stations and would be suitable for either tramway or lighting work.



CROSS-SECTION THROUGH VALLEY ROAD (No. 3) GENERATING STATION.

A scheme was accordingly prepared under the direction of Mr. R. A. Chattock, the city electrical engineer, during the period 1900-3, for another generating station to accommodate 20,000 H.P. when finished. The scheme provides for two parallel engine rooms, each capable of holding 10,000 H.P., and a boiler house in between.

The boilers are arranged in two rows, with a central stoking floor, over which are situated coal bunkers having a capacity of 2,000 tons.

A main flue running under each row of boilers, an economiser and chimney, will be provided for each side of the boiler house, each side being complete in itself in this respect.

This station adjoins the one previously described; the first engine house, which is 236 ft. long and 36 ft. wide, runs parallel with Valley Road, on to which a handsome stonework front faces. The interior is lined throughout with ornamental glazed bricks, and the roof also is completely glazed. The boiler house, immediately behind it, will eventually be 86 ft. wide, in three bays.

The overhead coal bunkers are constructed in steelwork and supported on stanchions. In shape they form two V-shaped troughs, from the bottom of which spouts will deliver coal to stoker hoppers on either side. At present some eight Babcock boilers are installed, on the side nearest to the engine room. Each boiler is capable of evaporating 18,000 lbs. of water per hour, and is fitted with mechanical stokers of the chain grate type, and standard type of superheater.

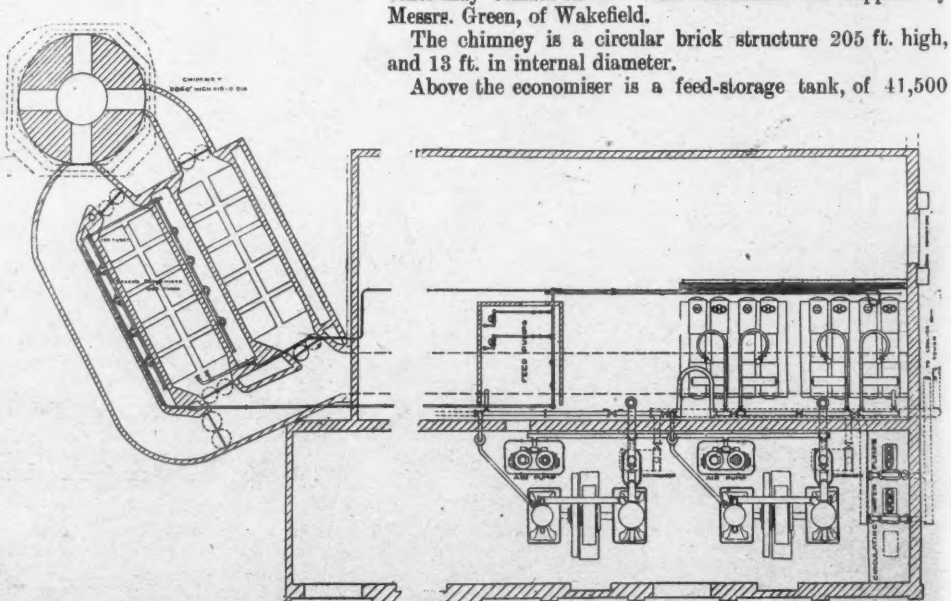
These boilers each have two steam drums, 48 in. in diameter, and 23 ft. 7 in. long. Each boiler contains 252 tubes, 4 in. diameter, and 18 ft. long, arranged in 18 vertical rows. They are also fitted with a double-spring loaded safety valve, and a double dead-weight safety valve.

The steam pipes are all of lap-welded steel, with flanges riveted or welded on; they were supplied by Messrs. Babcock and Wilcox. A main steam ring is arranged vertically, behind the boilers, the lower half being 10 in., and the upper half 7 in. in diameter. Each boiler branch feeds into the 10 in. steam main, and is provided with stop and isolating valves.

The steam valves are all of the full-way type, and have cast-steel bodies; they were supplied by Messrs. Marchant, of Huddersfield. Drain pockets and traps are provided on the 10 in. steam main, and from it the branches to the engine separators are led through openings in the wall. The economiser, situated in a building at the base of the chimney, contains 1,200 tubes, and is divided into halves, so that in case of breakdown, or if from any other cause one section is disabled, the other may remain in use. The economiser was supplied by Messrs. Green, of Wakefield.

The chimney is a circular brick structure 205 ft. high, and 13 ft. in internal diameter.

Above the economiser is a feed-storage tank, of 41,500 gallons capacity, also an ash bunker, arranged in connection with the conveying plant, and provided with shoots for filling carts.



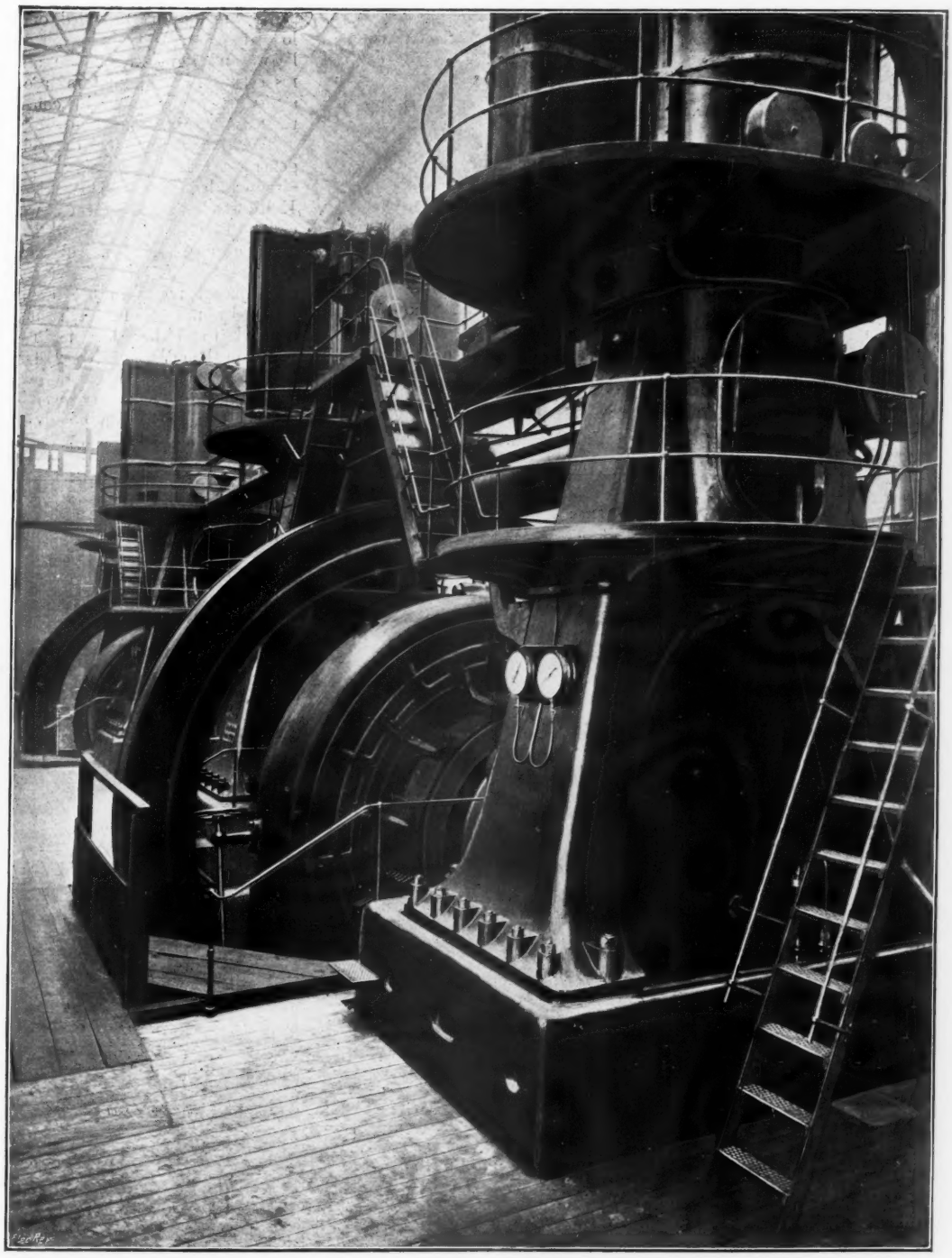
PLAN OF VALLEY ROAD (No. 3) GENERATING STATION.

A combined coal and ash-conveying plant is being installed by Messrs. Graham, Morton & Co., of Leeds. The

conveyor is of the endless chain and bucket type, with a capacity of 50 tons per hour, and is provided with automatic filling apparatus, both for coal and ashes. The conveyor will run vertically up the end wall of the boiler house from the coal-filling hoppers, passing over the top of the coal bunkers and down the end wall adjacent to the ash bunkers, into which it is arranged to deliver ashes, completing the circuit by passing along the boiler house basement to the coal filling hopper.

allowed for a pump room, in which are at present installed two steam feed pumps, supplied by Messrs. Weir, of Glasgow, each capable of delivering 7,500 gallons of water per hour to the boilers. The pumps draw from the storage tank over the economisers, or from the hot feed tanks (supplied from the hot wells), and deliver either direct or through the economisers to the boilers. Duplicate feed-pipe lines are provided, and duplicate steam connections to the feed pumps.

The first engine house is designed to accommodate five



1,000-kw. Cole, Marchent & Morley-Westinghouse Sets, Valley Road (No. 3) Station.

In the basement the ashes from the hoppers under the boilers will be fed into the filling apparatus, or in case of breakdown of the conveyor, into ash trucks, for which provision is made in the centre of the basement.

When the boiler house is completed, a second conveying plant of similar design will be installed, to deal with the second row of boilers.

Between the sixth and seventh boilers space has been

generating units, each of 2,000 h.p. The first two of these are at work; the engines were supplied by Messrs. Cole, Marchent & Morley, of Bradford, and the generators by the British Westinghouse Co., of Trafford Park.

A third set is in process of erection, with engines by Messrs. J. Musgrave & Son, of Bolton.

The engines are of the cross-compound inverted vertical type, with the generator placed between the high and low-pressure engines. The engines at present running have high-

pressure cylinders 27 in. and low-pressure cylinders 54 in. in diameter, with a stroke of 4 ft. 2[illegible].

On the crankshaft is mounted, beside the generator, a fly-wheel, 50 tons in weight and 20 ft. in diameter.

Outside View of Valley Road Generating Stations (Nos. 2 and 3).

Both cylinders are fitted with Corliss valves actuated by Messrs. Cole, Marchent & Morley's well-known type of trip gear.

Each engine is provided with a separate atmospheric exhaust pipe and surface condenser; the former comes into action through the opening of an automatic valve, in case of failure of the vacuum through the condensing plant breaking down.

The condenser and air pumps are situated at the rear of each engine, partly below the engine room floor level, but open to inspection from above by the engine room staff.

In the exhaust steam pipe above the condenser is fitted a Baker oil separator.

The condensers are similar to those described in connection with the other station, and by the same maker; each contains 2,500 sq. ft. of cooling surface.

The air pump sets are Messrs. Cole, Marchent & Morley's standard pattern, steam-driven by compound 10-in. stroke engines, running at 150 r.p.m., with 18-in. pumps of the Edwards type.

These pumping sets are also fitted with two force pumps for delivering the hot-well water into the overhead feed tanks.

All the condensers are coupled to a common air pump suction pipe, and any air pump can be used for creating a vacuum. The circulating water is at present supplied from the Allen pumping plant installed in the extensions to the original Valley Road station, and described in our last issue, but provision is made for installing three steam-driven circulating pumps at the end of the present engine room. The circulating inlet and outlet pipes to the condensers are placed in a covered trench at the rear of the boilers, beside the main flue, where also boiler blow-off and water-service pipes will be installed.

The generators fitted to these engines were built by the British Westinghouse Electric and Manufacturing Co., of Trafford Park, Manchester. They are each of 1,000 kw. capacity, and built to run with a 50 per cent. overload, if desired.

The armature complete weighs 19½ tons; it is keyed to the crankshaft, and bolted to the fly-wheel.

The magnet ring is fitted with 12 poles, compound wound, and is constructed in halves, which can be slid outwards on either side from the armature, on an underbed, for purposes of repairs or inspection. On test these generating sets have given the following results:—Steam press 160 lbs., superheat 7 to 26° F., vacuum 24·25 to 25 in.; at ¾-load the steam used per I.H.P. and per KW.-hour, was 11·8 and 18 lbs. respectively, and at full load 13 and 19·6 lbs. respectively.

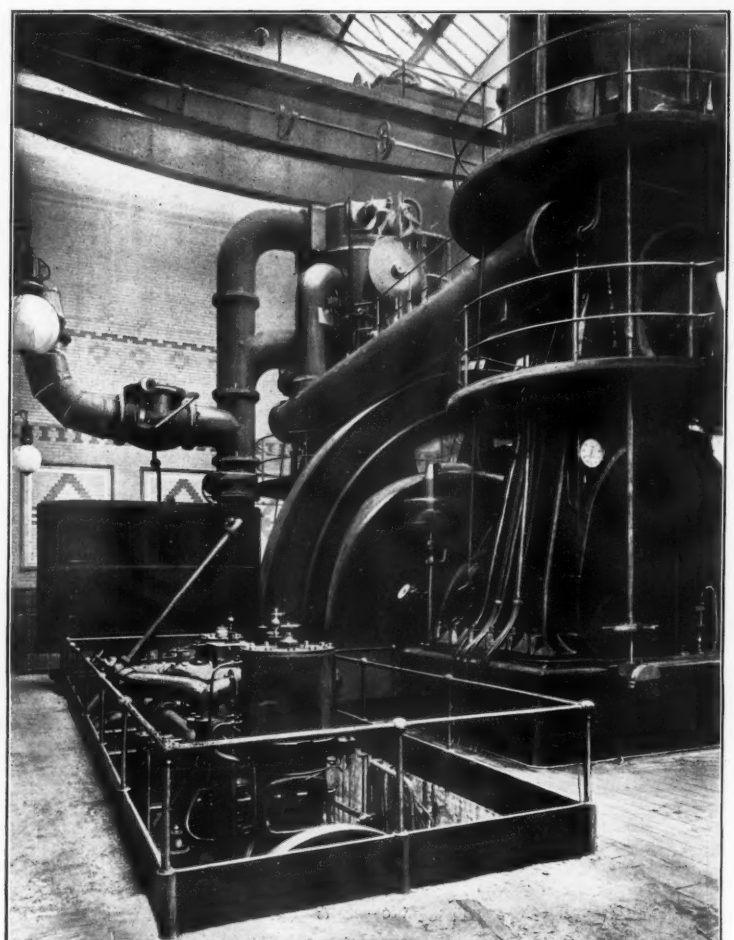
An electrically-driven overhead travelling crane is installed in this engine room. It was built by Messrs. T. Broadbent and Sons, Ltd., of Huddersfield.

Four motors are provided, one each for longitudinal and cross traverse and for heavy and light lifts of 30 and 8 tons respectively. The motors are of the series-type and worked by controllers of the tramway pattern.

The switchgear for controlling the generators at present installed, was constructed by Messrs. Ferranti, Ltd., of Hollinwood, and is of their well-known cellular type.

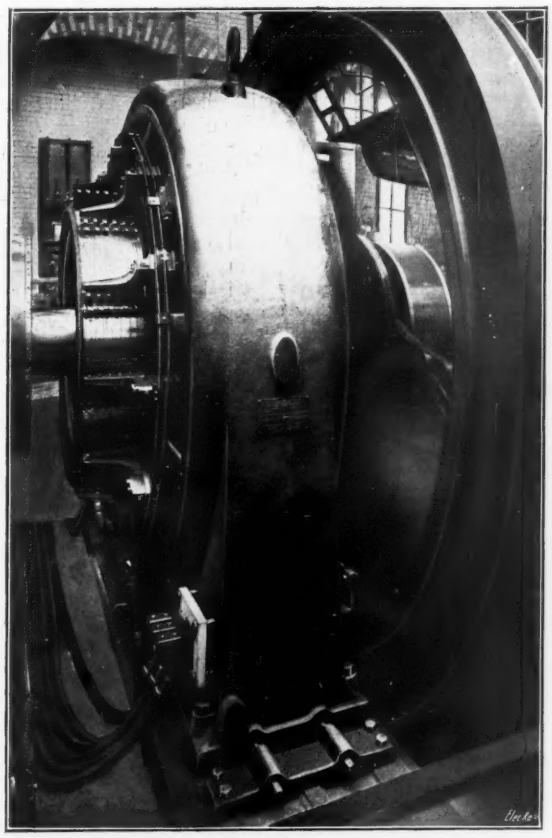
A separate set of switchgear is provided for each machine (situated in an adjacent recess in the engine room wall), by means of which it can be coupled to either the main lighting or traction switchboards in the adjoining No. 2 station.

In each gear two main circuit-breakers, arranged to open at 3,000 amperes maximum and 200 amperes reverse current, are fitted, the final break being taken on horn switches at the top of the board. A large three-part change-over and equalising switch, worked through a hand-wheel and worm gear, is arranged at the side of the last mentioned gear for putting the machine on the lighting or traction circuit. The usual ammeters, paralleling voltmeters, and field-controlling switches are provided.



View of Engines, Condensing Plant, &c., Valley Road (No. 3) Station.

The main switchboards in the No. 2 station have had a somewhat chequered career. The original lighting board, supplied by Mr. G. A. Steinthal, of Bradford, was situated



1,000-kw. Westinghouse Generator, Valley Rd. (No. 3) Station.

on a gallery at one end of the engine room. Of the chaos which reigned supreme in the restricted space at the rear of this board, perhaps the less said the better. While no doubt good specimen in its day, it was found inadequate for the more advanced conditions which now obtain in connection with the supply, so a new board, one of the first of the cellular type to be used for continuous current purposes, was installed by Messrs. Ferranti, on the engine room floor level, and some distance behind the older board.

It contains 24 machine divisions (two to each machine in the engine room), fitted with circuit-breakers of the carbon air-break type, with roller release devices, actuated by reverse and maximum current automatic attachments, knife switches, ammeters and B.T.H. watt-hour meters; three divisions contain the controlling switchgear, watt-hour meters, &c., for the works circuit subsidiary board, and 14 divisions the controlling gear for the various lighting circuits. Several spare divisions are left for extensions, and inter-connecting panels are provided for the large sets in the last described station and for the Willans-Bruce Peebles generating plant in the extension building.

All the ammeters and voltmeters are of the "edgewise" pattern, and are mounted on the top of the board.

The field regulating resistances are fixed to girders overhead, the hand wheels for operating them being about level with the top of their respective machine divisions.

The subsidiary board for controlling the works circuits is erected at one end of the main board. It controls some 20 circuits for motors and lighting, and is fitted with oil-break fuse plug switches. The six larger sets in this station have change-over and equalising switches fitted at the side of the generators. The traction board is situated at one side of the station, and was supplied by Messrs. R. W. Blackwell & Co. In this case also the original board has been reconstructed, and a different type of switch substituted.

The present board contains six machine circuits, a testing panel to comply with the Board of Trade regulations, and 10 feeder circuits, of which two are spares.

The machine panels are fitted with I.T.E. circuit-breakers, knife switches, ammeters, &c; the feeder panels have I.T.E. edgewise pattern circuit-breakers and knife switches.

Paralleling voltmeters and watt-hour meters for measuring the total traction output are provided.

The history of the Bradford distributing network to a great extent covers the various phases which have characterised this branch of electrical supply work since the two-wire system was in vogue. The supply originally commenced on the latter system at a pressure of 115 volts.

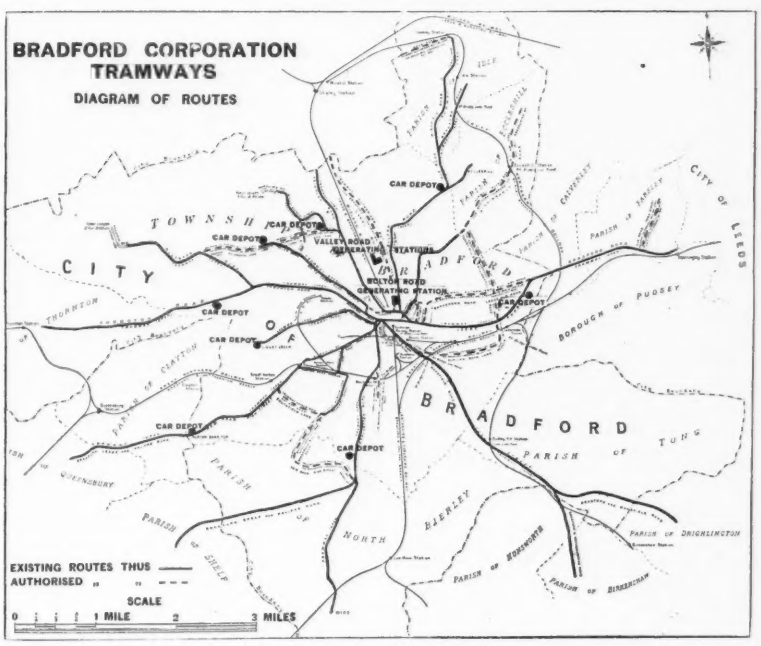
In 1893 the Hopkinson three-wire system of distribution was decided on, and a pressure of 230 volts across the outers adopted. The majority of the consumers' lamps were supplied at 115 volts, but a certain number of 230-volt lamps were employed as an experiment.

In the year 1897 a further change was made by increasing the voltage to 460 across the outers, and the use of 230-volt lamps having proved successful, they were generally adopted.

The credit for introducing the high-voltage lamp, must be given to Mr. Sydney Baynes, the electrical engineer from 1890 to 1895.

In 1897 Mr. Alf. H. Gibbings, the engineer at that time, introduced his scheme for the free supply of lamps to consumers, Bradford being the first town either in Europe or America where such an innovation was adopted.

In connection with the distributing network, there are 12 feeding points, the sections of feeder cables varying from 1·5 sq. in. to ·3 sq. in. The majority of the cables are of the B.I.W. and Siemens single-core armoured type, laid direct under the pavements, though a certain proportion of recent cables are laid on the solid system. The disconnecting boxes are of the diving-bell type with simple link fittings, and were originally designed by Mr. S. W. Baynes. The length of the longest lighting feeder is nearly 2 miles, and of traction



Map of Bradford Tramways.

feeder about 5½ miles, the latter feeders totalling some 46 miles. In connection with the distributing network, the department is at present constructing a cable tunnel, about

¼ mile in length, under the Midland Railway, to cross which it has previously been necessary to go a considerable distance round. The cables will be supported on hangers built into the sides of the tunnel.

A description of the Bradford electrical undertakings would not be complete without some reference to the city tramways. These are, in many respects, uniquely situated, as they form a connecting link between the tramway systems of Leeds, Halifax, Shipley D.C. and the Mid-Yorkshire scheme, and the Spen Valley system of the B.E.T. Co. Unfortunately, the gauge adopted at Bradford, viz., 4 ft., effectually isolates it as far as through running is concerned from the majority of its neighbours. The Leeds system meets it at Stanningley and Drighlington. The Halifax system adjoins it at Queensbury; the Shipley Council's route is at present worked by the Bradford tramways department, and will connect to the Mid-Yorkshire scheme, which is built to the same track gauge. The Spen Valley system of the B.E.T. Co. will meet it at Birkenshaw.

Camborne and Redruth Electric Tramway: Transport of Minerals.

The routes open at present total some 45 miles, of which 30½ are double track. The steepest gradient is 1 in 9, on the Church Bank section, and the cars on this route are equipped with special safety devices to prevent back running. The majority of the routes have steep gradients, the centre of the town lying in a hollow. Seven-inch girder rails, weighing 102 lbs. to the yard, have been mostly adopted, and a considerable number of Cooper & Howard Smith's patent anchor joints are in use. Certain sections of track have, however, been constructed on the Demerbe system.

The bonding of the rails is principally done with short Chicago Crown T. bonds, 4 in. centre to centre, fixed under the fish-plates for protection.

A number of special lay-outs in the centre of the city were specially made by Messrs. Hadfield's Steel Foundry Co., Sheffield, with their patent manganese steel rails, points and crossings.

The overhead equipment is of the usual standard pattern, centre-pole, side bracket and span-wire construction having been adopted on the various routes, and in certain places Edmundson-Purdom signals are installed for controlling the working of the cars.

The rolling stock consists of 228 single-truck double-decked cars, each carrying 52 passengers, and one single-deck double-bogie car to seat 40.

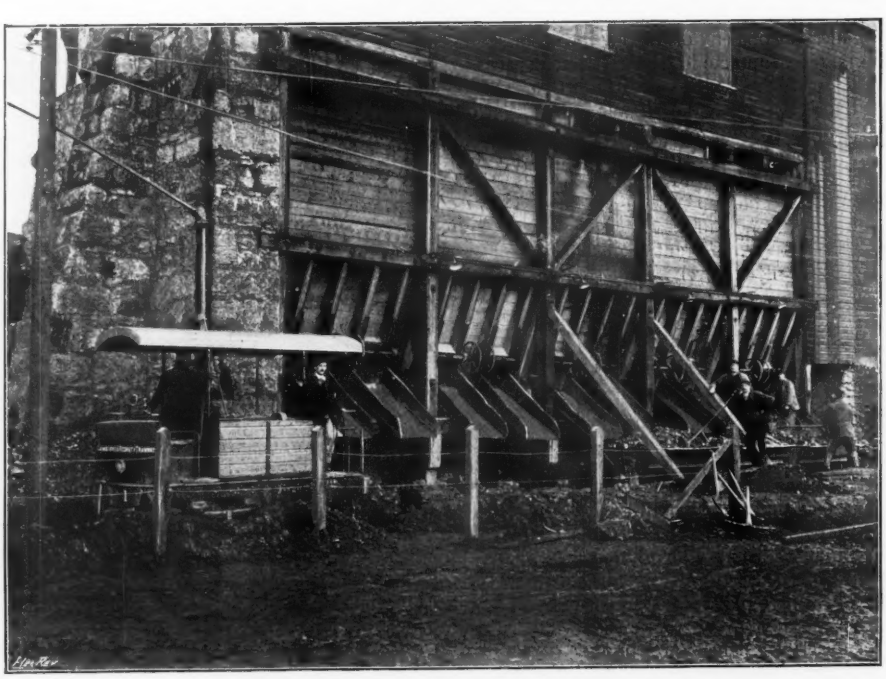
There are also five snow-ploughs and track sweepers.

The electrical equipments of the cars were supplied by Messrs. Witting, Eborall & Co. and the British Westinghouse Co., each car being provided with two 20-H.P. motors, and hand, slipper and electrical brakes.

The car depôts are scattered over the various routes; the principal one will hold 100 cars. At the Thornbury depôt a repair shop has been provided, where all the heavy repair work is executed. In this depôt a compressed-air equipment has been installed for the purposes of chipping, keyway cutting, drilling, and cleaning armatures and casings.

The first tramways in Bradford were opened in 1882, and the first electrical routes in July, 1898.

When the steam routes of the original companies were acquired by the Corporation, their conversion to electric traction was carried out by the municipality, and they were opened in February, 1902. The present position of the department will be gauged from the fact that during the year ending March last, 41 millions of passengers were carried and over 4,000,000 car-miles run.



Camborne and Redruth Electric Tramway.

Mr. A. Blackman is now the city electrical engineer.

In conclusion, we beg to thank the officials of the electricity department for their courtesy in supplying the particulars relating to that department, and Mr. C. J. Spencer, the general manager of the tramways, for information as to the Bradford tramway system.

CAMBORNE AND REDRUTH TRAMWAY.

The accompanying pictures show characteristic views on this electric trolley tramway, with cars carrying ore. We believe that this is the first time that such a system has been called upon to carry both passenger and mineral traffic in this country. The Urban Electric Supply Co., Ltd., have contracted to carry all the ore from East Pool and Wheal Agar mines to the stamps at Tolvaddon, the distance being about a mile. The quantity which has to be carried per day is about 200 tons.

The construction of the line, &c., was carried out for Messrs. Edmundson's Electricity Corporation, Ltd., by the resident engineer and manager (Mr. F. S. Hanning), on the same lines as the building of the power station and the construction of the permanent way; in fact, he was responsible for the entire equipment of the lighting and tramway system without any contractors, excepting Messrs. Callender's Cable and Construction Co., who carried out the cable work to the resident engineer's instructions for the four Board of Trade orders—*i.e.*, Camborne, Redruth, and Illogan lighting orders, and Camborne and Redruth tramway order. Over 100 miles of cable have been laid in mains and network.

The equivalent number of 8-C.P. lamps connected is 6,000, the number of motors 17, aggregating about 200 B.H.P., and the number of tramway motors 10 = 500 B.H.P., making the grand total equivalent to 25,000 8-C.P. lamps. Such a result for 12 months' working would be considered excellent in many of the large industrial towns in the United Kingdom. For instance, Rochdale, with a similar combined system, and a population of 83,000, has only the equivalent of 18,000 8-C.P. lamps after three years' working.

The ore is carried from the mines over about half a mile of Camborne and Redruth tramway permanent way, leaving the latter at the power station, Carn Brea. A light railway has been laid down on private property crossing two main roads to the stamps at Tolvaddon, a distance of about ¾ mile. In the construction of this it was necessary to build a bridge over the Gas Works Road, and a large amount of levelling had to be done. A trestle bridge was also found necessary from the second to the third stamps, owing to the difficulty of getting curves of a reasonable radius in such a cramped area. This special work, in conjunction with the permanent way, produced many difficulties in the shunting of trucks and locomotives, owing to the limited space at the constructor's disposal.

The company have also arranged with the Post Office to have letter boxes on their cars; letters are to be collected hourly at Camborne and Redruth, a start being made in this direction on January 1st, 1904.

The two locomotives were supplied by Messrs. Milnes, and the electrical equipment, motors and controllers, &c., by the British Thomson-Houston Co., Ltd., each loco. having two 25-H.P. motors of the K 60 type. There are 14 side-tipping steel trucks—eight carrying 2¼ tons per truck, and six 3 tons per truck. These trucks are provided with powerful brakes on all four wheels, and a train will consist of three trucks and a loco. so that there will be three trucks loading, six trucks and two loco.'s on the journey, three trucks discharging, and two spare trucks to allow for repairs.

The ore will be carried between the hours of 7 a.m. and 5 p.m., Sundays excluded.

BUSINESS NOTES.

(*Continued from page* 1029.)

Books Received.—"Light Railways Procedure," Vol. II., by J. S. Oxley. London: P. S. King & Son. 21s. net.

"Annuaire du Bureau des Longitudes pour 1904." Paris: Gauthier-Villars. 1·50 fr.

"Calvert's Mechanics' Almanack for 1904." London: John Heywood. 4d.

Trade Announcements.—We are asked to state that the liquidation of the British Schuckert Electric Co., Ltd., which has already been mentioned in these columns, is consequent upon the Schuckert & Siemens amalgamation in Germany, and the interests of the Schuckert Co. in Great Britain have now been entrusted to Messrs. Siemens Bros. & Co., Ltd., Westminster.

Messrs. G. E. Taylor & Co., electrical engineers and contractors, have removed to more commodious premises at 8, Bush Lane, Cannon Street, E.C., owing to increase of business.

Stealing Copper Cable.—At Guildhall on 17th inst., William McConkey, Ernest Ezra, James Brown, Frederick Kerr, and David Lang, all in the employment of the Charing Cross and City Electricity Supply Corporation, Ltd., were charged on remand with stealing various quantities of copper cable. Alfred Toms, a marine store dealer, of 120, Old Street, was brought up on remand charged with receiving the property—6 cwt. of cable, value £18—well knowing it to have been stolen. Mr. Alderman Smallman sentenced Ezra to one month's imprisonment, and McConkey, Brown, Kerr and Lang each to six weeks' imprisonment, with hard labour. He sentenced Toms to six months, with hard labour.

Kettering Street Lighting.—The Gilbert Arc Lamp Co., Ltd., are carrying out the street lighting here for Messrs. Kennedy & Jenkin, who have advised the Council to install the company's 6-ft. carbon open type lamps there, burning about 60 hours.

Bankruptcy Proceedings.—The first meeting and public examination in the case of Mr. J. W. Storr, electrical engineer, Dudley, are to be held at Dudley on December 29th and January 18th respectively.

Telegraph Cable Imports.—The value of the foreign telegraph cables and apparatus connected therewith imported into this country during November last amounted to £5,782 as compared with £5,419 in October last, bringing up the total for the first eleven months of the year to £55,981.

ELECTRIC LIGHT AND POWER NOTES.

Abercarn.—The U.D.C. has decided to defer application for a prov. order to supply electricity.

Andover.—The T.C. has resolved to oppose the application of the Southern District Electricity Supply Corporation for supplying electricity to the district.

Ayr.—The T.C. has agreed to supply energy to the Glasgow and South-Western Railway at 3d. per unit on a minimum consumption of 30,000 units p.a. and up to 50,000, and over that, at 2½d. per unit.

Barnet.—The E.L. sub-committee of the T.C. has interviewed the North Metropolitan Electrical Power Distribution Co., on the question of supply, and the company proposes to cancel the present order under which it is working and apply to the B. of T. for a new one, covering the area of Arkley, the company to pay the Council the cost of the order for the present extended district. The company proposes that the agreement with the T.C. shall be extended for a further period of seven years.

Beverley.—The Lincolnshire and Yorkshire Electric Power Co. has informed the T.C. that it proposes to apply for power to erect an electricity works in the Council's district.

The T.C. has paid Mr. Baker £130 for preparing a scheme for the lighting of the town.

Blairgowrie.—The T.C. is considering the electric lighting of the town, and on the 16th inst. interviewed certain gentlemen in connection with a scheme. It is proposed to utilise water-power from Benecally.

Bristol.—The Electrical Committee has decided to extend an alternating current main to New Brislington. Extensions have been authorised also to Phippen Street, Malago Vale, Bedminster and Queen Street.

Cardiff.—The Corporation on 15th inst. approved of the extension of the power station at Roath, in order to meet the increased demands of the electric lighting department. The cost of the building will be about £9,000, but no estimate can be given as to the cost of the plant until the extent of the increased demand is known.

Carnarvon.—The T.C. has approved of the North Wales Power Co.'s Bill, and has constituted the E.L. Committee a Watch Committee to protect its interests.

Chesterfield.—The T.C., on the recommendation of its electrical engineer, Mr. R. L. Acland, has decided to obtain another 400-KW. set for lighting and power, and to expend £100 on compounding two of its existing sets for dealing with the traction load. The estimated cost of the extensions, which will bring the capacity of the plant up to 1,000 KW., is £5,680.

Coventry.—The E.L. Committee of the Corporation has recommended the expenditure of £31,575 on extensions, being the completion of the original scheme which was decided upon as the result of Mr. Jeckell's report on the financial aspect of the undertaking. In regard to the borrowing of £5,000 sanctioned by the L.G.B. for the purchase of electric motors, the latter will be purchased as required.

Dewsbury.—A L.G.B. inquiry was held recently relative to the Corporation's application for a loan of £9,920 for electrical purposes. Part of the loan is for further extensions, and the balance to meet outstanding liabilities. There was no opposition.

Doncaster.—The T.C. will shortly consider the question of applying for further powers to extend the limits of its present area of supply, which will include Balby-with-Hexthorpe, Wheatley, Warmsworth, Bentley-with-Arksey, Kirk Sandall, Loversall, Sprotborough, Cantley, Armthorpe and Carr House-with-Elmfield, and also further provisions with regard to supply.

Dublin.—At a special meeting of the Dublin Corporation, the report of the E.L. Committee, embodying a letter from the L.G.B. in regard to the application for £48,000, to complete the City electric lighting scheme and to carry out the Clontarf scheme, was adopted after prolonged discussion. The L.G.B. state that £41,500 of the above sum represents an under-estimate of the cost of the scheme, notwithstanding the fact that a saving of about £6,000 was effected by the modification of the original estimates; also that about 87 per cent. of the work for which the above loan is required appears to be due to expenditure which will not increase the earning capacity of the system. The original estimate for the Pigeon House scheme was £254,000, and that sum, and £52,300 in addition, has now been spent.

Eastbourne.—A L.G.B. inquiry was held recently into the application by the T.C. for power to borrow £10,000 for electric lighting purposes.

Edmonton.—The Council has resolved by a majority of two votes, to carry out its prov. order itself. Several offers had been received from various firms for taking over the undertaking.

Elland.—The T.C. has resolved to make application to the L.G.B. for sanction to borrow £4,000 for extensions at its electricity works.

Farnborough.—The B. of T. has written to the U.D.C. inquiring whether the Council has taken any steps to carry out its proposal to transfer its prov. order to Power and Traction, Ltd., or to establish works under the order. The Council has replied that no application has been made by Power and Traction, Ltd., for the transfer of the order.

Gillingham (Dorset).—Messrs. Parry, Ross and Richards have submitted to the P.C. a scheme for electric lighting. They propose to convert an old silk mill into a generating station, and to supply energy for public lighting at 5d. per unit on an annual consumption of 50,000 units. The scheme has been adopted, and a company will be formed locally to carry it out.

Gorton.—The T.C. has applied to the B. of T. for an extension of time to enable the Council to carry out the works authorised by its order.

Hanley.—The T.C. has decided to obtain alternative tenders for the provision of turbines and reciprocating engines at the electricity works.

Hornsey.—The D.C. has resolved to put an end to the agreement with the National Electric Free Wiring Co.

Keynsham.—The R.D.C. has received a communication from a firm acting on behalf of the Keynsham Electric Light and Power Co., stating that the company would be willing to fix the price of energy at 11s. 8d. up to 20 units, and 7d. a unit after.

Kirkcaldy.—The T.C. has reduced the price of energy for power to 1½d. per unit, up to 6 p.m.

Lincoln, South America.—A small electric lighting plant of 35 KW. has been inaugurated recently.

London.—ISLINGTON.—The B.C. has agreed that, in the event of the L.C.C. sanctioning the borrowing of £849 for electric lighting purposes for a period of 42 years, it will undertake that during the currency of the loan no further loans will be raised to replace any of the plant and machinery, the cost of which is to be defrayed out of such loan, and that any renewals required during that period shall be provided out of a sinking fund to be created for the purpose, or from maintenance account.

WESTMINSTER.—The claim for £30,000 compensation by Pendarves Trustees against the L.C.C. for the freehold of the premises used by the Metropolitan Electric Supply Co., Sardinia Street, and required for the new thoroughfare—Kingsway—has been settled by consent at £24,754.

MARYLEBONE.—A special meeting of the B.C. has been held to consider the recent judgment by which the Council is to pay the Supply Co. £60,000 by January 31st next. It was decided to take the necessary steps for obtaining an over-draft for that amount from the Council's bankers, in lieu of levying a rate, for which there was not time. Mr. Edward White moved that a Bill be introduced into Parliament to relieve the B.C. from the obligation to purchase the Supply Co.'s Marylebone undertaking upon equitable terms. The discussion was adjourned.

The Lothians.—The chairman of the Lothians Electric Power Co. stated at a meeting of the company on the 17th inst. that the Fife Electric and Scottish Central Co.'s might possibly unite with the Lothians Co. All three companies propose to supply energy in bulk.

Lymington.—The R.D.C. has given permission for the local electric lighting company to extend the mains to Pennington.

Paignton.—The U.D.C. has appointed Messrs. Enright and Co. consulting engineers re the E.L. scheme at a fee of £400.

Redfern, N.S.W.—Owing to a breakdown of the boilers in the borough electricity works, the streets were recently in darkness for three nights.

Salisbury.—The Board of Guardians has decided to engage Mr. L. Andrews, late of Hastings, to advise it on the question of installing the electric light in the Workhouse.

Southampton.—The Inland Waterways, Ltd., have informed the T.C. that they intend to apply to the B. of T. for a prov. order to supply energy within its area. The Corporation will oppose the application.

Spain.—A concession has been granted to put down a plant to utilise the water power of the River Tago, at Sacedon, in the generation of electrical energy for lighting and power purposes.

Springwell.—Arrangements have been made by the Council for a supply of energy for public lighting from Springwell Colliery.

Strabane.—The T.C. has resolved not to assent to the Ulster Electric Power Co. applying for powers to light its area.

Swinton.—The U.D.C. has resolved to communicate with the Salford Corporation and the South Lancashire Tramways Co. to ascertain the most favourable terms upon which a supply of electricity in bulk can be obtained by the Council.

Tamworth.—The R.D.C. has assented to the application of the T.C. for a prov. order, and a committee has been formed to protect the Council's interests. The P.C. of Bolehall and Glascote, in the Council's district, has decided to oppose the T.C. on the ground that it has no proof that the T.C. would supply it with energy.

ELECTRIC TRACTION NOTES.

Birkenhead.—The T.C. on Friday decided to offer a salary of £450 to the new manager of the electric tramways, in order to secure a competent man. Mr. A. B. Fearnley, who is relinquishing the position, was appointed at £300, and a year later his salary was increased to £450.

Cardiff.—The electric tramways are to be extended from Castle Road to Crwys Road, from Rhymney railway bridge to Talygarn Street, and from the Cowbridge Road terminus to west of Victoria Park, Canton, at a cost of £17,673.

Chatham.—The Chatham and District Light Railways Co. is making great progress in the extension of its electric tramlines in the district. It is now just completing a through line running from the Dockyard and Naval Barracks on to New Brompton and Gillingham by way of Middle Street, Old Brompton. When this is complete, which will be in a few days, passengers will be able to ride all round the district at a 2d. fare. The company is now accommodating the public with a double line up the long hill leading from the east end of Chatham to Gillingham and the Rainham district. It has also powers to go on to Rainham and Maidstone, and it is expected that shortly these routes will be commenced.

Huddersfield.—The traffic receipts for November amounted to £4,777 5s. 2d., or 8·81d. per car-mile, an increase of £459 7s. 6d. The number of miles run was 130,201, and the passengers numbered 911,788.

Italy.—It is announced from Naples that a new electric railway connecting Resina with the first station on Cook's funicular line on Vesuvius is shortly to be opened for traffic. The line, which will be only 7½ km. long, has a difference of altitude of 700 metres. The highest section for about one-fifth of the total length is on the rack system (Strub's arrangement). The line has been built by Thos. Cook & Sons, the well-known tourist agents, with a view to facilitating approach to the crater.

The Minister of Public Works has authorised the railway company to suspend the service of accumulator traction on the Bologna-St. Felice-Poggio Rusco and Bologna-Modena Lyons railways, the trials not having given satisfactory results.

New York City.—A police report issued on December 4th shows that of 365 persons killed in the city streets during the past year, 172 deaths were caused by the electric street cars. Usually no penalty attaches to the motor-man, nor damages to the company. Only nine deaths were due to automobiles.

Oswaldtwistle.—Accrington T.C. has approached the U.D.C. on the question of extending the electric tramways to the town.

Perth.—The Tramways Committee had before it on 16th inst. a dozen applications from various firms for the work of carrying out the reconstruction of the tramways for electric traction. The clerk was instructed to inquire what contracts the applicants had already carried out, and report at a future meeting.

Russia.—The British Vice-Consul at Sevastopol reports that the Russian Government has decided to construct an electric railway between Sevastopol and Yalta, to pass *vid* Balaclava, Bida, Aloupka and Livadia.

South Shields.—Our Northern correspondent learns that the Tramways Committee has very materially altered its decision in respect to the leasing and construction of the tramways. The recent suggestion was that the Committee should have power to construct the tramways, but that the question of leasing them should be left over for the present; the intention having always been to construct the tramways municipally, whether they were afterwards leased or not. Now, however, after a consideration of the points involved, the Committee is going to recommend the Council to advertise for offers for the leasing, as well as for the construction and electrical equipment of the tramways.

TELEGRAPH AND TELEPHONE NOTES.

Brighton Telephones.—At last week's T.C. meeting Councillor Carden, chairman of the Telephones Committee, referred to the Postmaster-General's letter, which was mentioned in our last issue, and said the Committee regretted that the Postmaster-General had come to this decision without waiting to hear the Committee's side of the question. He hoped the Committee's reply would fully make out the justice of their case. He felt, however, that in the interests of the Corporation he could only bow to the decision.

Italian Telephones.—Telephonic communication has just been established between Rome, Florence and Naples.

P.O. Telephones.—At Richmond on 16th inst. the Post Office Telephone Exchange was formally opened.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1903	
St. Lucia-Martinique	May 7, 1903	
Anjer-Kaliandа	Aug. 2, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Beissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Tourane-Amoy	Nov. 10, 1903	
St. Jacques-Haiphong	Dec. 15, 1903	
St. Thomas-St. Kitts	Dec. 21, 1903	
Landlines.		
Rowno-Odessa	Dec. 14, 1903	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—December 28th. Coal-handling plant for the electricity works. See "Official Notices" December 11th.

Belfast. — January 15th. Electricity meters. See "Official Notices" to-day.

Enniscorthy.—January 20th. Electric lighting and pumping plant (seven sections), for the Lunatic Asylum. See "Official Notices" December 4th.

Erith.—January 18th. Lancashire boilers, piping, condensing plant, three-phase steam alternator of 500 kw., switchboard and cable extensions. See "Official Notices" December 18th.

Govan.—December 28th. Coal bunkers, conveyor, and electric capstan. See "Official Notices" December 4th.

Hackney.—January 4th, 1904. Feeding and distributing mains. See "Official Notices" December 11th.

Harrismith (Orange River).—January 18th. Cables, transformers, switchgear, &c. See "Official Notices" December 11th.

Kettering.—January 9th. Electricity meters. See "Official Notices" December 18th.

Lanark.—January 11th. The County Council and Middle Ward District Committee want tenders for refuse destructor and electric lighting plant, &c. Specifications, &c., from W. L. Douglass, district engineer, Hamilton.

L.C.C.—January 19th, 1904. Six electrically-driven three-throw boiler feed pumps for Greenwich power station. See "Official Notices" November 20th.

Spain.—Tenders are at present being invited by the municipal authorities of Plencia (Vizcaya province) for the concession for the electric lighting of the town during a period of four years. Tenders are to be sent to El Secretario del Ayuntamiento de Plencia (Vizcaya), whence particulars may be obtained.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Sydney (N.S.W.).—December 30th. Telegraph, telephone, and electric light material for the Deputy Postmaster-General of Sydney. See this column for November 6th.

Sydney (N.S.W.).—January 12th, 1904. Messrs. Preece and Cardew want tenders for :—One or two 600-kw. or one 1,200 kw. three-phase steam alternators with condenser, pipework, motor-generators, transformers, switchboards, &c., and a coal and ash conveyor. See "Official Notices" December 11th.

Wallasey.—January 16th. Cables, joint and section boxes. See "Official Notices" December 18th.

Walthamstow.—January 1st. Permanent way, gas plant, engines, dynamos, batteries, switchboard, cables, overhead equipment, &c., for 11 miles of line. See "Official Notices" December 4th.

CLOSED.

Cardiff.—The Tramways Committee has accepted the tender of the British Westinghouse Co., for 15 single-deck combination tram-cars, at £601 10s. each.

Faversham.—The Council has accepted the tender of the British Westinghouse Electric and Manufacturing Co., Ltd., for pumps at the electricity works, at £135, and that of the Brockie-Pell Co., for arc lamps, with automatic switches for incandescent lights on arc lamp-posts.

Halifax.—The Board of Guardians has accepted the tender of Messrs. Sunderland & Co. for the installation of the electric light in the new board room, at £258 12s. 6d.

Hull.—The Corporation Tramways Committee has accepted the tender of Mr. E. A. Lackenby, for the supply of 14 tram-car covers of the Kennington type, at £80 each.

Ipswich.—The T.C. has placed an order for an additional 360-i.h.p. set for the electricity works with the Electrical Co., at £1,611.

London.—The Highways Committee of the L.C.C. has reported upon the tenders received for the supply of 12,500 tons of rails, fastenings, conductor tees, &c., which are required in connection with the reconstruction of certain portions of the tramways. The specification for these materials was divided into two parts—track rails and slot rails, and fastenings in each case. The lowest of the 14 tenders were :—

Track Rails, &c.

Name of firm.	Amount.	Remarks.
Charles Frère, jun., Brussels.	£40,418 13 6	Basic steel tendered for.
P. & W. Maclellan, Ltd., Glasgow.	41,581 17 10	Basic Bessemer steel.
A. Penney & Co., London.	42,065 19 0	Do. Do.
Bolling & Lowe, London.	42,414 8 2	Do. do.
M. Korten, London.	43,250 0 6	Do. do.
J. G. White & Co., Ltd., London.	43,353 1 0	Do. do.
The Lorain Steel Co., U.S. America.	43,389 3 0	Will not accept penalty for delay in delivery.
Bolckow, Vaughan & Co., Ltd., London.	43,748 9 0	Acid steel tendered for.

For the slot rails 16 tenders were received, the lowest being :—

The Lorain Steel Co., U.S. America.	£33,979 0 0	Will not accept penalty for delay in delivery.
P. & W. Maclellan, Ltd., Glasgow.	34,067 12 6	Basic Bessemer steel tendered for.
J. G. White & Co., Ltd., London.	34,649 10 0	Acid steel tendered for.
Bolling & Lowe, London	34,896 19 2	Basic Bessemer steel.
Pennsylvania and Maryland Steel Co., U.S. America.	35,958 10 0	Delivery in quantities given as far as shipments by steamer allow.
Frodingham Iron and Steel Co., Ltd., Doncaster	36,461 15 0	Acid steel.
Bolckow, Vaughan & Co., Ltd., London	36,871 12 6	Do. do.
Steel, Peech & Tozer, Ltd., Sheffield	36,923 0 0	Do. do.

In regard to these tenders, the report states :—"The tenders have been carefully examined by the engineer, who has advised us that, as regards the supply of track rails, that of Messrs. Bolckow, Vaughan & Co., Ltd, amounting to £43,748 9s., should be accepted. The six lowest tenders for the supply of the track rails provide for the use of basic steel, while the specification issued required that the rails to be supplied should be made of acid steel. We were advised by the chief engineer that as the rails which have hitherto been supplied have been made of basic steel, it was important that, in order that a fair comparison might be made of the relative life of rails made of these two forms of steel, the rails now required should be made of acid steel. The next tender, that of the Lorain Steel Co., of America, cannot be considered, as the company is unwilling to accept the clause with reference to the incurring of penalties in the event of non-delivery within the time specified. In the circumstances, we are of opinion that the tender of Messrs. Bolckow, Vaughan & Co., should be accepted. This firm, who are very large manufacturers of rails, have, we are informed, carried out very important contracts in a satisfactory manner. The whole of the work under the contract will, we understand, be executed by Messrs. Bolckow, Vaughan & Co. themselves.

"With reference to the supply of slot rails and conductor-tees, we are advised by the engineer that the tender of the Frodingham Iron and Steel Co., Ltd., amounting to £36,461 15s., should be

accepted. The lowest tender is that submitted by the Lorain Steel Co., who in this case also have intimated that they would not be prepared to accept the proposed clause with reference to payment of penalties in the event of late delivery, and we have therefore not considered their tender. The four next tenders lower in amount than that of the Frodingham Co. provide for rails of Belgian or American manufacture, and, in view of the extra expenditure which would have to be incurred in arranging for the proper inspection and supervision of the carrying-out of the work, we are of opinion that the tender of the Frodingham Iron and Steel Co. should be accepted. This tender provides for steel of English manufacture, and it is only £2,394 2s. 6d. larger in amount than the second tender, that of Messrs. P. and W. Maclellan, which is for rails of Belgian manufacture.

"As the Council is aware, the last contract entered into for the supply of rails provided for steel of Belgian manufacture, and it is satisfactory to note that the tenders which we propose should be accepted are 7 per cent. lower in amount, although providing for goods of British manufacture, than would be the case were they based on the prices in the contract last entered into."

Northampton and Sunderland.—Messrs. E. Allen & Co., Ltd., have recently secured a large contract for the Northampton Corporation Tramways through Messrs. J. G. White & Co., Ltd. (the contractors) for cast-steel points and crossings, with tongues and renewable pieces in their Imperial manganese steel, and cast-iron bound crossings with manganese steel centres. They have also secured a contract for the Sunderland District Tramways, through Messrs. A. Krauss & Sons, of Bristol (the contractors) for the whole of the cast-steel points, fitted with manganese steel tongues and crossings required in the construction of these tramways.

Portsmouth.—The Corporation Telephone Committee has accepted the tender of the International Electric Co., of London, for the extension of the switchboard by 300 direct lines, with an ultimate capacity of 360 more, at £645.

The Corporation has accepted the tender of Messrs. Milnes, Voss & Co., for a car-roof cover as an experiment, at £65.

Walsall.—The Corporation has accepted tenders as follows:—Bumsted & Chandler, for a 500-H.P. engine, £1,430; and Thos. Parker, Ltd., for supplying magnets for dynamos, £740.

FORTHCOMING EVENTS.

Tuesday, January 5th.—London Electrical Contractors' Association. Paper by R. B. Johnson on "The Necessity for the Standardisation of Wiring Rules."

NOTES.

A Merry Christmas.—We take this opportunity of wishing all with whom we come into touch through the columns of the ELECTRICAL REVIEW a right merry Xmas.

British Electrical Friendly Society.—The second annual general meeting of this society was held on Monday, December 14th, at Essex Hall, Essex Street, Strand. Mr. W. G. Bond presided. The report of the Central Committee stated that there are now 30 branches and 1,989 members, a net increase of seven branches and 636 members. The income from all sources during the year was over £3,010, as against £1,130 for the preceding period. The expenditure for sick pay was over £1,844, death claims £59, and medical fees over £316. The chairman, in moving the adoption of the report, called attention to the very heavy sickness experienced during the year, and expressed the hope that it would be a long time before such an unusually heavy year would again be experienced. Mr. E. Garcke, who had retired from the chairmanship of the Society, was elected a trustee.

Gas Engine Developments.—At a meeting of the Junior Institution of Engineers, held on December 4th, Prof. D. S. Capper read a paper on "Recent Developments in the Construction and Working of Gas Engines."

Personal.—The Marquis of Tweeddale presided on 17th inst. at the Hotel Cecil over a dinner given to Mr. George Draper by his former colleagues on his retirement from the service of the Eastern Telegraph Co. Mr. Draper became connected with the Anglo-Mediterranean Telegraph Co. in 1869, and was appointed secretary of the Eastern Telegraph Co. in 1872, and of the Eastern and South African Telegraph Co. in 1879.

Mr. Graham Harris desires to thank the many friends for their letters of sympathy with him, on the death of his partner—Sir Frederick Bramwell, Bart. Having regard to the very large number he has received, he has found it impossible to send individual replies, and trusts his friends will, therefore, accept this expression of his thanks, and his appreciation of their kindness.

Electricity and Fires.—Before the Insurance Society of Edinburgh last week, Mr. Henry R. L. Burn, of the North British and Mercantile Insurance Co., read a paper on "Electric Light Supply and Precautions against Fire." He emphasised the necessity of installations of electricity being carried out by first-rate firms, for if they were to believe the assessor's reports, "scamping" must be accountable for many of the fires, as they found it reported that the cause of fire in many cases was through defective installation. In conclusion, Mr. Burn gave particulars of losses which had been incurred by fires, many of which had peculiar origins. In one case, he mentioned that owing to the wind swaying a ball lamp, the coil became frayed, and damage to the extent of £8 was done. He cited a case in which £1,400 damage had been done to a church, and stated that buildings which were not frequently tenanted should be fitted with some automatic arrangement which would give warning when necessary.

An Electrical Coal Feeder for Gasworks.—At the Congress of the Société Technique de l'Industrie du Gaz, held last May in Toulon, a mechanical stoker working by electric power was described by its inventor, M. de Brouwer, director of the gasworks at Bruges. The machine is said to act well, does not require a costly installation or skilled attendance, and is applicable to small as well as large works. It consists of three pulleys of different diameters forming a group. The two smaller pulleys are connected by a belt which runs over them, and they are kept in rotation by an electric motor applied to the larger of the two. Their axles are not in the same horizontal plane, the smaller pulley being at a lower level, so that the belt is inclined to the vertical at an angle of about 45°. The third pulley presses on the belt midway between the other two and is thus kept in motion. Its circumference is hollowed like a tube, and the coal, falling from a hopper, is caught in the tube and carried round by centrifugal force with such an impetus that it shoots away from the pulley in almost a horizontal stream into the mouth of the furnace. Besides not requiring the ordinary stoking operations, the method has the unexpected advantage of not producing so great an accumulation of graphite in the furnaces, apparently because of the air carried by the shoot of coals into the fire. The machine is used in works at Bruges, Toulon, Barcelona and elsewhere. It promises well for coke furnaces and war ships.

New Mercury Vapour Lamp.—For some time past Mr. C. O. Bastian, well known for his electrolytic meter, has been engaged in perfecting a new type of mercury vapour lamp. This has now progressed so far that we may hope to hear of its practical application as soon as patent formalities have been complied with, and arrangements made for the manufacture of the lamp in quantity. The light is of a remarkably penetrating character, and quite suitable for street lighting without modification; by a simple and ingenious device, however, Mr. Bastian has succeeded in improving the colour of the light and rendering it suitable also for indoor lighting, the white light emitted being, in fact, perfectly satisfactory for even such trying purposes as matching colours. This modification involves a slight loss of efficiency, but even so, the efficiency is far higher than that of any glow lamp. Moreover, the lamp is self-starting, lighting up directly it is switched on. Further details will be given as soon as they are available.

Radium.—A lecture on "Radium and Radio-activity" was delivered on 18th inst. by Mr. John Gray, B.Sc., A.R.S.M., under the auspices of the Aberdeen Mechanical Society. Prof. Japp presided. Mr. Gray, by means of interesting experiments, illustrated the peculiar manifestations of the activity of radium. The effect of these new discoveries upon the old atomic theories came under consideration, and provoked a brief discussion, in which the chairman naturally took the side of the chemists. He thought that Mr. Gray went a little too far in speaking of the downfall of the atomic theory. Mr. Gray, in reply, thought Prof. Japp would admit that in the lecture he did not quite relegate the atomic theory to a place where it would be simply old furniture. He had no doubt that long before it was actually proved experimentally, the more far-seeing chemists thought that in certain cases certain atoms break up, and among these they had to place Prof. Japp, who had warned his students that such a thing might take place.

Lecture.—Under the joint auspices of the Notts Education Committee and the Midland Branch of the National Association of Colliery Managers, a lecture was delivered in Nottingham University College, on Saturday, by Mr. W. Maurice, M.I.M.E., on the subject of "Practical Colliery Electricity."

A Gas Engine of Beam Type.—Mr. Morgan presents a paper to the American Society of Mechanical Engineers describing a gas engine specially designed for blast furnace and producer gas, in which the power of the engine is passed through an oscillating beam to the connecting rod and crank. The beam, such as it is, is very short, but the compactness claimed is not very striking. The author has something to say about the dust in blast-furnace gas, but is clearly unacquainted with the successful and pioneer work done in this country, and only takes up the tale at the point where the Cockerill Co., finding they were mistaken in attempting to use uncleaned gas, began to clean it by centrifugal fan blowers, the centrifugal fan, by the way, having been used by Thwaite in the first blast-furnace gas engine at Wishaw, which was at work before the Cockerill Co. found out the mistake of using dirty gas. The centrifugal cleaning was not a German discovery, as Mr. Morgan thinks. It is at least satisfactory to find that the Americans are actually beginning to wake up to the value of blast-furnace gases. We have found our English iron-masters slow enough in grasping the importance of the matter, but American hustlers have been slower still, for they appear to have done next to nothing yet.

Engineering Training.—At a meeting of the North-East Coast Institution of Engineers and Shipbuilders in Newcastle-on-Tyne last week, an important scheme was adopted for the training of apprentices and pupils in workshops. The *Times* says:—"The committee believed that youths intending to become artisans should receive while at school the best training possible, including instruction in elementary science, and that more attention should be given to the inculcation of habits of order, perseverance, and good conduct, and that these studies and habits should be developed in the workshop by a system of rewards offered by employers. They believed that industrial conditions in this country called for some change in the methods of selecting and training those destined to work in the higher branches of engineering and shipbuilding. The committee felt that if we were to maintain our position in those industries in which science played an important part, more vigorous efforts than hitherto must be made to secure the highest and most suitable education and training for adequate numbers of selected youths. The scheme adopted outlined a scheme for the reception into the works of apprentices and pupils, including a system of training and of promotion according to merit. It was stated that these regulations had been approved by most of the employers in the district."

Society of Engineers.—The annual general meeting was held on Monday, December 14th at Westminster. The chair was occupied by Mr. J. Patten Barber, President. Mr. David Butler Butler was elected president for next year.

The following premiums were awarded by the Council for papers read during the past session, viz.:—The President's Gold Medal to Mr. Douglas Mackenzie for his paper on "Motor Transport for Goods"; the Bessemer Premium of Books to Mr. Robert J. Thomas for his paper on "Road Maintenance and Administration"; and a Society's Premium of Books to Mr. Albert Gay for his paper on "Mechanical Stokers for Electricity Generating Stations."

Electro-Pneumatic Signalling.—The North-Eastern Railway Co. have introduced a large installation of electro-pneumatic signalling on their Sunderland and North Shields line at Harton Colliery. This is the first instance of its adoption for the passenger traffic of the North-Eastern Railway. A Birmingham newspaper says that in order to ascertain the relative merits of the three power signalling systems now engaging the attention of British railway officers, the North-Eastern Co. will shortly lay an experimental installation of low-pressure air signalling at Paragon Station, Hull.

Will.—The *Times* says that Mr. David Tullis, of Glencairn, Burnside, Rutherglen, and of Messrs. John Tullis & Sons, Ltd., of Glasgow, leather merchants and manufacturers of machinery belting, who died on September 27th, left estate valued at £119,844 7s. 10d.

The Sterilisation of Water by Means of Ozone.—A description has been published by Marmier in *L'Electricien* of a plant for sterilising water by means of ozonised air, which is in use at a large brewery at Marseilles. The ozoniser consists of a glass case containing two glass plates, fastened at a distance of 1·3 to 1·4 millimetres apart. These carry the electrodes between which the electric discharge is produced. The original current is obtained from an alternator at a pressure of 60 volts, and is led to a transformer which raises it to a voltage of 40,000. Air which has previously been dried by passing over pumice moistened with strong sulphuric acid is forced by means of an electrically-driven pump into the glass case at a pressure of 10 to 20 millimetres of water column; it then flows between the glass plates, leaving the apparatus through a tube, the mouth of which is arranged almost centrally about one of the plates. The ozonised air passes to the sterilising plant along an earthenware pipe, a diaphragm of known aperture being placed in it, and, in front of the diaphragm, a delicate pressure gauge. In this way it is easy to calculate the quantity of air flowing through the ozoniser in a given time. The steriliser is a cylinder of masonry 6 metres high and 3 metres in diameter, filled with quartz pebbles from 2 to 6 centimetres in diameter. The water enters at the top, and trickles downwards over the stones, meeting the ozonised air which is travelling in the opposite direction. The crude water treated contains 1,800 or 2,000 micro-organisms per cubic centimetre, but after passage through the apparatus it only retains 1 colony per 1 to 3 cubic centimetres. The plant is capable of purifying 20 cubic metres of water per hour, 3·5 metres of ozonised air being required of a strength equal to 6 grammes of ozone per metre. In other words, 1 volume of ozonised air purifies 6 volumes of water, or 1 gramme of ozone 1 cubic meter of water.

It will be remembered that in January last we gave a description of a similar plant for purifying the water supply of Wiesbaden.

Shop Construction.—Mr. Schæffler, of the American Society of Mechanical Engineers, makes a suggestion in a paper to that body, of a new design of shop which he lays out as an eight-armed spider, one arm representing the entrance, and the other seven various shops radiating from a common centre, at the eye of which he places his octagonal administration building. The idea is, however, not new, and though it may have certain good points, it involves an enormous amount of waste space. In practice we doubt if the system of parallel shops can be improved upon. One of the best systems of shop construction is that of the Allis Engine Co., of Milwaukee. A pattern shop and a foundry, parallel with each other, are placed at right angles with the machine and erecting shops, so that there is a given length of pattern shop and of foundry for each of the separate and distinct engine shops. The whole works is really made up of five smaller works, any section of which can be cut off without affecting the others. Such a plan can, of course, only be employed for a very large works which can be divided up into several shops, each complete in itself. The author of the paper before us states that his radiating system is carried out in the Eastern Penitentiary of Pennsylvania. If workshops are to be based on the plan of a penitentiary, credit should be given to the old pentagon known as Millbank prison, which once stood where the Tate Gallery now stands.

The Economy of Superheated Steam.—A paper on this subject was read by Mr. E. M. Reynolds before the Rugby Engineering Society on December 17th. The possibility of superheat was brought about, he said, by the discovery of heavy mineral lubricants and metallic packing. There is some reason in this, but it must be remembered that a rod which is running through a stuffing box, has either just come from contact with the cold atmosphere, or it has been in contact with exhaust steam. Superheated steam does not get to the rod packings, though it may be admitted that the rod surface is never so cold as when there is no superheat. It is a pleasure to see that the author does not claim any thermo-dynamic advantage from superheat. He very rightly states that if the adiabatic cylinder could have been materialised, we should never have heard anything of superheat. He states very clearly what it is that superheat really does and how it works by reducing cylinder condensation, and also piston and valve leakage. A formula by which he correlates pressure, temperature and volume is $pv = 93{\cdot}5\,T - 91\,p^{0{\cdot}25}$ where p is measured in pounds absolute per square foot, v is the volume in cubic feet of 1 lb. of steam, and T is the absolute temperature in degrees Fahr. This formula, he states, shows that at 300° of superheat the volume of steam is increased 50 per cent., but he does not state the saturated temperature from which the 300° superheat is measured.

He appears, however, not to be clear on the question of specific volume and calorific capacity. Superheated steam has less heat, we are told, per cubic foot, and, therefore, less heat enters any given cylinder per stroke than when saturated steam is used; yet the same amount of heat is converted into work. This idea is erroneous. In a heat engine that fluid is best which contains the maximum heat in a given space, and that fluid is dry saturated steam. But we can never have dry saturated steam at cut-off. We always get about a third or a half or more of water in addition. It is this water which is not only a direct carrier-off of heat, but also acts perniciously as a cooling agent upon the cylinder, as the author himself shows just previously. Superheated steam gains nothing by its volume. It simply loses its superheat and its super-volume together in securing dry saturated steam at cut-off. Superheat perishes that the cylinder may be dry at cut-off. Pipes may be smaller with superheated steam because, being unloaded with water, it travels faster, but one should not forget that it is also bulkier than saturated steam. Still there is less weight needed for the same duty, and perhaps 20 per cent. is a suitable reduction for steam pipe area. Then the loss due to separators is avoided, and there are various other incidental economies. The author did not consider that engines required to be very different for superheat. Certainly the piston runs away from superheat, and upon colder surfaces, but the admission valve is all the time bathed in superheat, and if there is to be any difference made it must be in the valves.

The author is one of those who realise that the separately fired superheater is necessary for boilers of the water-tube type, which cannot be arranged to contain at once an efficient and safe superheater. He sees that either there will be little or no superheat, or the tubes will be burned out. He does not, however, show how the separately fired superheater can be made at once safe, efficient, economical and controllable. The temperature of any furnace must be at least 2,500° F., and there are only two ways by which this can be brought down to about one half so as to be safely admissible to the superheater tubes. One is to drown the hot gases in an equal weight of cold air, whereby the efficiency of the fuel burned is reduced to about 20 per cent., and the other is to employ the excess of heat in useful work such as feed heating or even steam production, whereby the fuel efficiency may be 50 or even 60 per cent.

It is doubtful economy to superheat as to keep the steam dry through the whole expansion. In this event the cut-off must perforce be later, or one cannot use steam sufficient to do the work. It may be done where the first cylinder carries steam three-fourths of the stroke by carrying it even later, and having a very short expansion, but at reasonably early cut-off the superheat would be very high indeed. The author, however, prefers reheating between cylinders, and on the whole it is very doubtful if the first cylinder should receive steam much above 500° F. No oil exists beyond 650° F.; few, if any, are useful beyond 600°.

The author does not in any way touch upon the construction of superheaters, systems of control, or the prevention of burning out, and he leaves untouched all such questions as the loss of pressure which so many superheaters compel because of their very restricted areas. This restriction of area may cause a loss of pressure of even 15 per cent., and it seriously reduces the economy of superheat. A loss of 3 lbs. is ample in the superheater itself. The loss of pressure is due to the high velocity of flow allowed, with the very good intention of preventing overheating of the superheater tubes, but this is a very makeshift method of pipe preservation that cannot be permanent. It is a method that has been forced on the makers of certain superheaters by the mistaken ideas prevailing that anything will do for a superheater, and that a superheater is merely a sort of cheap accessory to a boiler. Properly understood, a superheater is of primary importance, demanding the best of constructional materials. It is exposed to most severe conditions of duty, and should be constructed so as to be safe and durable, and capable of controlling its own action within comparatively narrow limits of temperature.

Frictional Electricity in Cleaning Works.—Fires occasionally occur in "dry-cleaning" works where fabrics are freed from grease and dirt by immersion and agitation in light petroleum spirit, or one of the physically similar hydro-carbons obtained from coal tar. When the materials are taken out of the baths, especially if they are silk goods, and are subjected to friction, electric sparks are produced which ignite the highly inflammable liquids. Dr. Goehrig, manager of one of the large factories on the Continent where this cleaning operation is carried out, has succeeded in abolishing this risk by adding to the petroleum spirit 0·1 per cent. of a lubricant composed of 4 parts of olein, 4 parts of alcohol, and 1 part of ammonia; and by drawing the goods, as they come out of the baths, over metallic gauze. It is stated that although fires took place quite frequently in his factory some time ago, no accident of the kind has happened during the 10 years that this preventive method has been in regular operation.

Production of Cyanamide Salts.—A further patent, No. 16,298, 1902, has been taken out by H. H. Lake, of London, for the Cyanid Gesellschaft, of Berlin, for the manufacture of calcium cyanamide. A mixture of lime or chalk and charcoal is heated in an electric furnace to a temperature at which nitrogen is absorbed, but below that required for the formation of calcium carbide, about 2,000° C. being best. Nitrogen, or some gas containing nitrogen, such as air, is led over the mixture. An excess of carbon may be employed, and part of it may be used in some organic form such as pitch. A metal like iron may be added to the charge in order to increase the conductivity of the mixture. The product is mainly calcium cyanamide, which is a chemical variant of calcium cyanide, and it may be used either for the manufacture of the latter (whence the potassium cyanide of gold extraction processes may be prepared) or as an artificial manure. The operation, in fact, is an electrical method of "fixing" atmospheric nitrogen chiefly for agricultural purposes. Calcium cyanamide is, we believe, already on the Berlin market, and is known by the trade name of "Kalkstickstoff; it has been tested by several agricultural chemists in Germany, and found to be a perfect substitute for South American nitrate of soda, or the sulphate of ammonia of the gas trade.

Light Railways Act, 1896.—The Board of Trade has made an additional rule under the Act above named, with respect to the allowance of the expenses of local authorities. The rule will be placed on sale as a Government publication.

THE CENTRAL STATION ENGINEER.

Mr. Reed, of Manchester, has been appointed shift engineer to the electric light undertaking controlled by the Gillingham Corporation. There were 18 applicants.

NEW COMPANIES REGISTERED.

Torquay Electro-Therapeutic Institute, Ltd. (79,458).—This company was registered on December 16th, with a capital of £2,000 in £1 shares, to provide and maintain an establishment for the cure and relief of diseases and ailments by electricity or other kindred treatment, to provide and administer electric light baths, to carry on the business of electricians, electrical and mechanical engineers and suppliers of electricity, &c. The first subscribers (each with one share) are:—G. Williams, 12, Strand, Torquay, house furnisher; J. G. Harding, 5, Ideford Terrace, Chelston, Torquay, clerk; C. N. B. Pearce, Carina, Torquay, clerk; Mrs. M. E. Sparks, Carina, Torquay; W. F. Codner, 4, Forward Street, Torquay, butcher; C. P. Sparks, 5, Forward Street, Torquay, house and estate agent; and H. G. Sadgrove, Acocks Green, Birmingham, surveyor. No initial public issue. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, 100 shares; remuneration (except managing director), £20 each per annum. Registered office: 5, Forward Street, Torquay.

Tavistock and District Electric Supply Co., Ltd. (79,416).—This company was registered on December 12th, with a capital of £1,000 in £1 shares, to construct or acquire any tramways in Tavistock, or elsewhere in Devon, and to carry on the business of suppliers of electricity for light, heat, sound and power, electrical engineers, electricians, mechanical, practical and chemical engineers, &c. The first subscribers (each with one share) are:—W. T. Pressland, Broad Sanctuary Chambers, Westminster, electrical engineer; C. L. Cooper, 14, Gloucester Road, S.W., electrical engineer; G. D. Handley, Springvale, I.W., director of Handley's, Ltd.; A. West, Briarwood, Ryde, I.W., electrical engineer; E. W. Oakley, 118, Queen Victoria Street, E.C., incorporated accountant; C. S. Ashdown, 37, Ashworth Mansions, Maida Vale, W., clerk; and A. J. Fippard, Broad Sanctuary Chambers, Westminster, S.W., electrical engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company.

Electro-Sulphur and Light Co., Ltd. (79,436).—This company was registered on December 15th, with a capital of £5,000 in £1 shares, to establish, equip, open and carry on business as proprietors of water, light, electric and other baths and other appliances for the curative or sedative treatment of all or any organs of the body for therapeutic and other purposes, to administer light and colour treatment, and any other treatment involving the use of electricity with or without sulphur, water or other vehicle &c. The first subscribers are:—S. Armitage, Thames Chambers, Adelphi, W.C., civil engineer; J. Brodie, 55, Leadenhall Street, E.C., gentleman, with 100 shares; J. Ibbotson, 15, Fitzalan Square, Sheffield, woollen merchant, with 100 shares; M. B. Pearson, 31, Burnt Ash Road, Lee, Kent, shipowner, with 100 shares; C. E. Fothergay, 1, Gresham Buildings, Basinghall Street, E.C., solicitor, with 1 share; E. W. Harris, 11, Colchester Street, S.W., clerk; and D. C. Woollaston, 121, Mansfield Road, Gospel Oak, N.W., clerk, with 1 share. Minimum cash subscription £2,500. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Qualification £100; remuneration £250 per annum, divisible. Registered office: 142, Gray's Inn Road, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Penzance and District Electric Supply Co., Ltd. (79,415).—This company was registered on December 12th, with a capital of £1,000 in £1 shares, to construct or acquire any tramway or tramways in Penzance. The subscribers and all other particulars are the same as in the Tavistock and District Electric Supply Co., Ltd. (q.v.)

Ashford and District Electric Supply Co., Ltd. (79,412).—This company was registered on December 12th, with a capital of £1,000 in £1 shares, to acquire any tramway or tramways in Ashford, Kent. The subscribers and all other particulars are the same as in Tavistock and District Electric Supply Co., Ltd. (q.v.)

Mexico Electric Tramways, Ltd. (56,932).—A deed, dated December 2nd, 1903, covenanting to transfer to the trustees 30,000 ordinary shares of $100 each in the Companhia de Cos Ferro-carriles dél Distrito Federal de Mexico and 6 per cent. 2nd mortgage debentures issued by the Mexican Co. to the nominal amount of $1,833,100, by way of further security in respect of £400,000 debentures, has been registered. £270,000 of the said debentures were created by resolution of September 7th, 1898, and covered by original trust deed dated May 12th, 1898, and the remaining £130,000 were created by resolution of August 9th, 1899, and secured by a supplemental trust deed, dated January 28th, 1899. Trustees: L. Breitmeyer and C. Rube, both of 120, Bishopsgate Street Within, E.C. The whole series of £400,000 debentures has been issued.

Burnand Transformer Co., Ltd., Salford (73,049).—Issue, on December 3rd, of £1,275 debentures, part of series created same date, to secure £2,000, charged on the company's property, present and future, including uncalled capital and (as a floating security) the company's undertaking and property. No trustees.

British Electric Calibrated Fuse Co., Ltd. (78,486).—Issue, on December 4th, of £750 debentures, part of series created same date to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Lang, 137, Fenchurch Street, E.C. No trustees.

United Kingdom Tramway, Light Railway and Electrical Syndicate, Ltd. (62,887).—A memorandum of satisfaction in full of a mortgage dated October 20th, 1902, securing certain liabilities unascertained at the date of the mortgage (which was stamped to cover £3,800), including an advance of £300, has been filed.

ELECTRICITY SUPPLY ACCOUNTS.

Birkenhead Municipal Electrical Supply.

We give herewith an analysis of the returns of the Birkenhead electrical undertaking for the year ending March 31st, 1903. The supply steadily increases, and this year the gross profit amounts to £5,857, compared with £3,729 last year. The business portion of this area has always suffered from close proximity to its larger neighbour, Liverpool, which accounts for the comparatively restricted development in the supply for a town of its size. With the increase in output, a decrease has occurred in the works costs per unit, from 2·12d. to 1·65d.

The charges for energy are:—For private lighting, 6d., 3d. and 1½d. per unit on the maximum demand system; power, 2½d. to 1½d. per unit. Mr. W. Bates is the borough electrical engineer.

General Statement.

For year ending March 31st—	1903.	1902.
Total capital expended	£93,344	£73,841
Number of units sold—		
Private supply	452,722	353,495
Public lighting	94,916	38,021
Total number of units sold	547,638	391,516
Equivalent No. of 8-c.p. lamps connected	40,100	31,097
H.P. of motors connected	61 H.P.	40 H.P.
Number of public lamps	54 arc.	54 arc.
Maximum load in kw.	459	384
Revenue account—		
Gross revenue	£9,624	£7,167
„ expenditure	£3,767	£3,438
„ profit	£5,857	£3,729

Revenue Account.

	1903. Gross.	Per unit.
By sale of energy	£9,066	3·98d.
Meter and motor rents, &c., ...	558	·24d.
Gross revenue	£9,624	4·22d.

Cost of Production.

	Gross.	Per unit.
Coal and oil fuel	£1,224	·54d.
Oil, waste, water and engine room stores ...	216	·09d.
Wages incurred in generation and distribution	651	·29d.
Repairs and maintenance of buildings, machinery and plant...	390	·17d.
Works and distribution costs	£2,481	1·09d.
Repairs, attendance, &c., public lamps ...	289	·13d.
Rents, rates and taxes	200	·08d.
Management expenses, salaries of engineer and clerical staff	550	·24d.
General establishment charges, insurance, law, printing, and stationery	247	·11d.
Total works costs	£3,767	1·65d.

Profit Statement.	
Interest on loans	£2,631
Sinking fund	2,030
Balance transferred to renewals	1,196
Gross profit	£5,857

On the year's working, after meeting interest and sinking fund charges, a balance of £1,196 remained, which was transferred to the electric lighting renewals account. From this account, renewal of batteries has been met, and a balance remains of £996.

CITY NOTES.

Johnson-Lundell Electric Traction Co.

The report for the year ended June 30th last, which was submitted at the meeting on the 22nd inst., states that at the last annual meeting shareholders were informed of the steps which had been taken with a view to perfecting the company's motors and controllers, and it was pointed out that if further improvements could be effected, the gain in efficiency might be increased to 40 per cent. At the same time certain defects in the smoothness of operation called for a remedy before the apparatus could be accepted generally by tramway managers. To enable these improvements to be carried out, Messrs. Holmes & Co., who were interested in the promotion of this company, agreed to lend £10,000 at a low rate of interest, this sum not to be repaid unless the company became an assured success. During the past year continuous attention has been given by the technical staff of the company towards accomplishing the objects in view. Twenty motors and controllers were built in Berlin. Fresh patents have been taken out, incorporating new and valuable features, while a braking system has been devised, which, it is anticipated, will be adopted generally for tramway work. It is now reported that the objects aimed at have been accomplished. A car fitted with the new apparatus has been run on trial at Newcastle. This trial was attended by the directors, the committee appointed at the last meeting of shareholders, and other leading shareholders. Arrangements have been made to have independent efficiency tests applied by leading authorities, and to have the operations watched by tramway and electrical engineers. If the apparatus should prove as efficient as it is claimed, its value cannot fail to be established as an important and striking advance upon present standard methods of electric traction, and lead to early development on commercial lines. The long delay in reaching these results has been a matter of grave anxiety to the board. The impatience which many shareholders have manifested has been shared to the full by the directors, but they were powerless to expedite a process of improvement which depended upon highly-skilled experts working upon a problem which had taxed the brains of electrical engineers for many years. The accounts show an excess of expenditure over income for the year, of £6,946, making a total to date of £17,734.

The meeting held at the offices on Tuesday was private, our representative being informed that it was a mere formal one, and that there was no business to be transacted. It is believed that the proceedings stand over until January.

The British Westinghouse Electric and Manufacturing Co.

The fourth annual report of this company reads:—

"The directors submit herewith the balance-sheet for the year ending July 31st, 1903, together with profit and loss account to that date, which shows a profit of £107,609 7s. 6d. This includes about £60,000 special discounts allowed by the American companies on orders executed at Pittsburg. It was felt by the American companies that these discounts should be made in view of the fact that the Manchester factory could turn out only about one-third of the electrical apparatus needed for its orders, and had therefore to purchase the balance from the Pittsburg factories. An interim dividend at the rate of 6 per cent. per annum upon the preference shares has been paid. After providing for debenture and loan interest, and the further items set out in the profit and loss account, a balance remains of £47,106 8s. 1d. Out of this sum the directors recommend the payment of a final dividend at the rate of 6 per cent. per annum on the preference shares, absorbing £45,961 13s., carrying the balance of £1,144 15s. 1d. to reserve. This being the first year during which the company's works have been equipped, it has not been thought necessary to make any provision for depreciation of buildings and machinery. The total authorised share capital of the company has now been issued. Under the provisions of the articles of association the directors have created a further £450,000 4 per cent. debenture stock to rank *pari passu* with the £787,500 previously created. £50,000 of this further debenture stock has already been issued. In order to make provision for maintaining a sufficient supply of stock at the company's works and for other purposes to meet the requirements of the increasing business of the company, the directors will propose to the meeting that an additional 100,000 6 per cent. preference shares of £5 each, ranking *pari passu* with those already existing, shall be created. Arrangements have been made under which the subscription to these shares will be assured. The works at Trafford Park, Manchester, are now employing over 5,000 hands. The following particulars are given as indicating the growth of the company's business:—Orders received during the year ending July 31st, 1901, £738,000; July 31st, 1902, £932,000; July 31st, 1903, £1,657,114. Among other important contracts obtained during the past year by the company are those with the Admiralty, the Midland Railway Co., the Metropolitan Railway Co., the North-Eastern Railway Co., the Underground Electric Railways Co., of London, Buenos Ayres Western Railway Co., Buenos Ayres Great Southern Railway Co., De Beers Consolidated Mines, London County Council, and the Corporations of Aberdeen, Bath, Bournemouth, Glasgow, Hackney, Ipswich, Liverpool, Salford, and Dunedin, N.Z., and the Savoy Hotel Co. Mr. C. W. Benson retired as on July 31st owing to ill-health, and the directors have accepted his resignation with regret. In pursuance of the articles, the retiring members of the board are Sir Joseph Lawrence, M.P., and Mr. J. W. Cloud, who are both eligible, and offer themselves for re-election. Messrs. Deloitte, Dever, Griffiths & Co. offer themselves for re-election as auditors for the ensuing year."

The New Gutta-percha Co.

The second ordinary general meeting of the shareholders of this company was held on Friday last at Winchester House, Old Broad Street, Mr. Hugh Woolner presiding.

The Chairman, in proposing the adoption of the report, said that the period covered by the report was really only 14 months. There was an item of £25,000 on the debit side of the account, unpaid purchase-money to vendors, and he would like to say that the vendors had assigned all the patents to the company, absolutely free of all liens. The gross profit of £394 appeared insignificant, but they had not yet been able to get into what he might call the commercial stride owing to various causes over which the directors had no control. The chief cause was their inability to get some portions of the machinery which they required for their plant, and they also had to meet the scepticism which had been engendered in the minds of the users of gutta-percha, who were tired of even testing new substitutes, and they had not been able to do more than get the large and important users of the article to begin a series of tests which involved at least a year for their completion; they had therefore, to bow to the inevitable and await the results. Mr. James Swinburne, the eminent electrical engineer, had tested the material, and had issued a report of a highly satisfactory character, in which he said he was of opinion that it was suitable for submarine cable purposes. They had also submitted a coil of wire to the Post Office experts, with the result that they had received an order for five miles of wire, and undoubtedly other orders would follow. They also looked for large orders from railway companies, and had received one order in open competition. There was another field open to them which was quite as large, viz., the use of a suitable modification of their production as a substitute for vulcanised india-rubber, which was largely used in electric lighting undertakings. As to the profits they were likely to make, the shareholders would appreciate the reticence of the board on that point at that early stage of their development, and he trusted they would be satisfied with the statement that, if they only captured 5 per cent. of the trade in gutta-percha and india-rubber, they would be able to earn a dividend of 50 per cent. upon their total authorised capital. The directors felt assured that in their material they had got that which had been sought for for the last 30 years.

Mr. P. E. Beachcroft seconded the motion, which was carried.

Metropolitan District Railway Co.

On 17th inst., at the Westminster Palace Hotel, the new Bill of this company came before shareholders for their approval. Mr. R. W. Perks, M.P. who presided, said that it was an omnibus Bill. One of the important matters with which it dealt was the fares to be adopted in consequence of the adoption of electric traction. The conversion of the line from steam to electricity would be finished in about 12 months from the present time. On the subject of fares, he and his colleagues considered that the ideal which they ought to attain was a uniform rate over the whole of their railway—one rate and one class. Unless their expectations as to the number of passengers they would carry were utterly erroneous, the rate would probably be a 2d. one for everybody everywhere. At the same time, provision would be made, by means of a special car on such trains as might be found necessary, for people who wished to travel in somewhat more luxurious fashion than sitting side by side with what was popularly known as the British working man. Their Bill would be confined to what they called zone fares. They proposed to fix zone fares, treating Hammersmith as the zone centre. From there to everywhere eastward, right down to Aldgate, would be 2d. for everybody. That was to say, from Hammersmith, Walham Green, Earl's Court, High Street, Kensington, South Kensington, Victoria, Westminster, Charing Cross, Whitechapel—from all those stations to Bow Road, and the reverse journey, they would charge a uniform rate of 2d. These would be material reductions. Further alterations would necessitate negotiations with other companies. They did not think that the estimates of the traffic on which their new charges were based were exaggerated. They were now carrying yearly close upon 50,000,000 fares, 10,000,000 of them being contributed by the working classes. They did not think it at all unreasonable to expect to double their traffic when they had more than doubled their accommodation, because they contemplated running 40 trains an hour, as against 18 at present. They would thus provide for 140,000,000 fares in the rolling stock now in course of construction. He assured the share-

holders, and through them the public, that nothing on the line would be liable to catch fire. The directors were even going to abolish the wooden platforms, which were so familiar to the London public, and substitute cement platforms. The staircases would be constructed of non-burrable material, the cars of non-inflammable material, and the Board of Trade were discussing other precautions. Agreements for the equipment of the line had been entered into with the Underground Electric Railway Co., but they had nothing to do with the present Bill. The agreements threw upon the Underground Co. an absolute obligation to convert the District Railway from steam to electricity, to provide the whole of the rolling-stock, and build the power house at Chelsea, without imposing any monetary obligation whatever upon the District Railway beyond the contract to issue stock for the work done. The stock would not be issued until the work was actually certified to be done, and this would answer the suggestion that the company would not be able to see their way through the conversion. The directors had now available for this specific purpose £1,048,750, which they believed would abundantly cover all the commitments for the completion of the enterprise. After the electrification the stock and shares of the company would stand as follows:—

Consolidated 3 per cent. rent charge ...	... £2,116,667
Debenture stocks at 4 and 6 per cent. ...	... 2,736,374
Four per Cent. Guaranteed stock ...	... 1,250,000
First Preference stock	... 1,500,000
Second Preference stock	... 1,050,000
Ordinary stock	... 3,235,000

At this particular juncture he ought to add that nearly all the material used upon the railway would be of British manufacture. That might console some of his patriotic listeners who were anxious that whatever was bought should not come from a foreign source. They were watching this matter with care. Of the 17 millions sterling which would be ultimately expended on the railways, certainly not more than 10 per cent. would be spent on material coming from any country outside the British Isles. That was to say, at least 15 millions would be spent on British labour and British-manufactured goods. The directors had hoped that the new railway would be opened by the spring, but it would have to be deferred until the end of the year.

The resolution adopting the Bill was carried unanimously.

Arc Lamps, Ltd.

Mr C. W. Milne presided at the meeting of this company held at Old Broad Street, E.C., on 17th inst. He dwelt at some length upon the various matters mentioned in the report, of which we gave an abstract in our last issue, and referred to the new 1904 lamp as an important discovery, the value of the patents for which it was difficult to over-estimate. The lamp had only one working part, and there were no dash pots, bobbins, springs, or complicated levers; it burnt equally well on direct and alternating circuits, and either in series or parallel, without alteration. This invention had given the company a new lease of life, and there was no necessity for a large writing down of the value of the patents this year, at any rate. After dwelling upon the litigation with the Jandus Co. in some detail, he moved the adoption of the report.

Capt E J. Bax seconded, and it was carried.

A final dividend at the rate of 7 per cent. per annum for the second half of the year was approved.

The Chairman subsequently explained the intention of the board to issue £2,630 in £1 shares, making up the total issued capital to £55,000. These new shares would be offered to the existing holders.

Birmingham and Midland Tramways, Ltd.

An extraordinary meeting of shareholders was held at Birmingham last week, Mr. C. S. Hilton presiding, to consider the provisional agreement made with the British Electric Traction Co. for the purpose of acquiring various interests in tramway undertakings in the Midlands, and also to confirm a proposal for increasing the capital of the company by the creation of 55,000 new shares of £10 each.

The adoption of the proposals was seconded by Sir Ernest Spencer, M.P., and unanimously approved. The resolutions were confirmed by separate meetings of preference and ordinary shareholders held later.

Scarborough Electric Supply Co.—The recent issue by this company of 1,000 ordinary shares of £10 each at £2 premium, has been over-applied for to the extent of nearly 100 per cent. Only existing shareholders were asked to subscribe.

British Columbia Electric Railway Co.—An issue of £45,000 4½ per cent. Vancouver Power debentures is being offered for subscription to the holders of the first mortgage debentures and Vancouver Power debentures of the company, and to the holders of the company's share and capital stock.

City of Buenos Ayres Tramways Co.—This company has issued a circular stating that negotiations have been opened with a view to the transfer of the company's undertaking to the Anglo-Argentine Tramways Co., Ltd.

STOCKS AND SHARES.

Monday Evening.

Threats of strife and warfare in the Far East come with strange inappropriateness at the season when the West is preparing for its peace and goodwill celebrations. The Stock Exchange, as always, feels the immediate effect of the apprehensions in regard to what may happen, and also how far this country may be dragged into the Russo-Japanese quarrel. Consols are flat, and the general disposition is to discount still further the possibilities of war. Besides this deterrent to business on the "long" side, the holiday currents of the atmosphere have a restraining influence over prospective buyers, and except in a few instances, the investment markets of the House show signs of general weakness.

Partly, no doubt, because the electric lighting shares are "full of dividend," the prices in the supply section keep very steady, and for the dulness of Metropolitans there is, of course, a special reason. The Marylebone Borough Council has been ordered to pay £60,000 to the company within the next five weeks, and the Council, it is stated, has arranged a loan for that sum with its bankers. But this drawing of the "first blood" has only served to awaken more vigorous hostility than ever to the terms of the arbitration award, and if the borough can find a way, like sentimental Tommy, it is determined to have the decision over-ridden. A few shareholders do not like the uncertainty of the position, and are realising their shares, hence the lowered price.

Turning to dividends, a few cases may be cited to show that the coming results are not likely to be any worse than those of 1902, and they may very probably be better. The Metropolitan, for instance, paid 14s. 6d. per share last year, but its August dividend was 8s., and more than a further 6s. 6d. is locked for now to complete the twelvemonths' distribution. The City of London shareholders got 10s. for 1902, and so far half that amount has been paid this year. The Brompton dividend in August was 4s. 6d., and proprietors received during 1902 only 8s. a share. In the same way the Westminster dividend in the autumn of 6s. 6d. would require merely 5s. 6d. more to bring it up to the distribution of last year, whereas appearances point to higher payments being made for 1903. It must again be noticed as curious that the investor should not make better use of his opportunities in this market.

Echoes of the Brush Second Debenture issue continue to make themselves heard, and the stock has changed hands one or twice during the past few days at about 80. It looks as though someone in the House must have what the Yankees colloquially call a pocket order.

Great Northern and City Railway Preferred "A" shares are easier at 7½, and shares have been done at 7⅝ and 7 7/16 since we last wrote. Apparently some of the underwriters kick at the long-protracted delay in opening the line, although this is promised for an early month in the new year. Criticism, too, is being directed to the difficulties that will arise in the transfer system at Finsbury Park, whereby passengers are to be handed from the Great Northern Railway to the new electric line, and *vice versâ*, by lifts. Electrical railway stocks otherwise merely mark time. Melancholy estimates of the City and South London still rule the price of the stock. The forthcoming announcement will go against one at the rate of 3½ per cent. last year, 2¾ per cent. in 1901, and 1¾ per cent. in the previous twelvemonth. On Central London Deferred the estimates range from 3 to 4 per cent., with opinion rather inclining to the higher rate, although the prices do not respond—in fact, the Deferred is a point easier.

At last the British Westinghouse report has appeared, and while the trading figures which it shows are truly enormous, the document failed to evoke any enthusiasm in the market because of the heavy new issue foreshadowed. If the company expects to get its coming 100,000 Preference shares subscribed at their par value of £5, something must either be done to render them very attractive, or else the current quotation for the existing shares will have to be raised from 4⅞, cum. 3s. dividend. It is stated, however, that the new issue enjoys a guarantee.

In the market they are assuming that City of Buenos Ayres Tramway shares will be made worth £10 as the result of the amalgamation with the Anglo-Argentine Co., but notwithstanding this, the price has slipped back to 8⅞. Naturally it will be some time before all the necessary arrangements are completed, and the market's assumption is but an approximate guess, although it will probably come near the mark. Anglo-Argentines are active about 4⅛, but the tramway department suffers from the prevailing lack of business.

Telegraph descriptions come into the same category. Prices remain steady, although the Eastern groups seem undecided as to how the Russo-Japanese imbroglio will affect them. It should at least be good for their business, and the more acute the crisis, the more messages will obviously pass. Anglo-American stocks display no special feature. Telephone varieties have been dealt in a good deal, but without causing any noteworthy change in prices; the Deferred is easier to the tune of a point.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Dec. 16th.	Closing Quotations Dec. 21st.	Business done week ended Dec. 21st, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	99 —103	99 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛ — 3⅛	2⅛ — 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	61s.	60/6	49 — 52	49 — 52	..	..
3,105,680	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 94	92 — 94	93⅜	92⅝
3,105,680	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	7⅜ — 8⅛	7⅜ — 8⅛	7⅛	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4½ — 5½	4½ — 5½	..	..
13,388,300$	Commercial Cable	$100	8 %	8 %	8 %	145 —155	145 —155	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	90 — 93	90 — 93	91	..
16,000	Cuba Telegraph	10	4½%	4 %	6½%	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅜ — 3⅛	2⅜ — 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	97 —101	97 —101	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10 — 10⅛	10 — 10⅛	..	..
67,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	122 —127	122 —127	123	122
1,955,565	Do. 8½ % Pref. Stock	100	..	..	..	85 — 88	85 — 88	88	87½
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11 — 11⅛	11 — 11⅛	11⅛	11⅛
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	106 —109	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 3,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	..	8¼ — 8¾	8¼ — 8¾	..	..
180,042	Do. do. 6 % Pref.	10	..	..	..	12½ — 13	12½ — 13	..	..
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	25 — 26	25 — 26	..	..
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 40	37 — 40	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	101 —103	101 —104	102⅝	102½
1,966,667	Do. do. Def. Stock	100	..	..	4½%	78 — 81	76 — 79	78	7⅞
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	13⅞	13⅝
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜	5⅛	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 98	96 — 98	96½	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	102 —104	103½	102½
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅞ — 1	⅞ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	.. — ..	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	5 %	..	6¾ — 7⅛	6¾ — 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	116 —121	116 —121	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5⅛ — 6	5⅛ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅞ — 5⅛	4⅞ — 5⅛	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	104 —107	..	..
15,809	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	11⅜ — 12⅛	11⅜ — 12⅛	..	..
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	99 —102	..	..
88,321	West India and Panama Telegraph	10	1%	..	..	⅜ — ½	⅜ — ½	..	..
94,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4¼ — 5⅛	4¼ — 5⅛	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	101 —104	101 —104	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4⅛ — 5⅛	4⅛ — 5⅛	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	88 — 92	88 — 92	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	11⅛ — 12 xd	11⅛ — 12⅛ xd	11⅞	11⅞
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11⅛ — 11⅝	11⅛ — 11⅝	11⅛	11⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	122½	122
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6 — 6⅛	6 — 6⅛	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	108 —108	108 —108	105½	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	9/- — 9/3	9/- — 9/3	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,781	Brush Electrical Engineering, Ord., 1 to 105,781	2	5 %	Nil	Nil	¾ — 1⅛	¾ — 1⅛	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1¼ — 1⅜	1¼ — 1⅜	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	78 — 85	78 — 85	83½	79½
35,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11 — 12	11 — 12	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5⅜	5¼ — 5⅜	5⅛	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	106 —110	..	..
1,960,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	93 — 96	93 — 96	94½	93
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	99 —102	99¼	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	96 — 99	95 — 98	96	..
1,980,000	City and South London Railway	Stock	1½%	2 %	3½%	47 — 50	47 — 50	48	..
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	5 %	1⅞ — 2⅛	1⅞ — 2⅛	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	99 —103	99 —103	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,189	Do. do. "A" shares, 01—017,189	5	2½%	Nil	..	¼ — ½	¼ — ½	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅝ — 1⅞	1¼ — 1⅝	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	..	..	..	2¼ — 3	2¼ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9⅞ — 10⅛	9⅞ — 10⅛	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	96 — 99	96 — 99	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	14 — 15	14 — 15	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5⅛	5 — 5⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18½ — 19½	19 — 20	19⅜	19
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
97,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5⅛ — 5⅛	4⅜ — 5	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½ — 10⅝	10½ — 10⅝	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	34 — 37	34 — 37	34½	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (continued).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Dec. 16th.	Closing Quotations Dec. 21st.	Business done week ended Dec. 21st, 1903. Highest	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord..	‡	..	..	..	⅜ — ⅞	⅜ — ⅞	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	1	..	..	..	.. — ..	.. — ..	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	100	..	..	..	116 —119	114 —117	..	..
20,000	Do. do. 7% Cum. Pref. ..	5	6%	8⅝%	9%	10¼— 10⅝	10⅜— 10⅝	10¼	..
50,000	Charing Cross and Strand Electricity Supply	5	..	..	..	10 — 10¼	9⅞— 9⅞	..	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	9%	10%	10%	8⅞— 9⅛	— ..	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
950,000	Do. do. 4% Deb. Stock Red.	5	..	..	..	4⅛— 5	4⅛— 5	..	..
44,486	*Chelsea Electricity Supply, Ord.	100	..	..	..	103 —105 xd	103 —105 xd	104¼	103½
150,000‡	Do. do. % Deb. Stock Red.	5	5½%	4%	4½%	5¾— 6	5¾— 6	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	Stock	..	..	..	107 —110	107 —110	..	..
40,000	Do. 6% Cum. Pref., 1 to 40,000	10	0%	5%	5%	10¼— 11	10 — 10¼	..	..
400,000‡	Do. 5% Deb. Stock, Scrip. (iss. at 115) all paid	10	6%	..	..	13 — 14	13 — 14	12	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	..	..	..	..	122 —127	122 —127	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	100	..	..	..	102 —105	102 —105	..	..
20,000	Do. do. do. 6% Pref., 40,001—60,000..	10	4%	4%	4%	7⅞— 8⅛	7⅞— 8⅛	..	..
400,000‡	Do. do. 4½% Deb. Stock	10	..	..	..	11¼— 12½	11⅜— 12½	12½	11⅜
250,000	Do. do. 4½% 2nd Deb. Stock	..	..	..	..	108 —111	108 —111	109½	..
50,000	Edmundson's Electric Corporation, Ord. Shares	Stock	..	..	..	99 —102	100 —100½	..	..
80,000	Do. do. 6% Cum. Pref.	5	7%	7%	7%	6 — 6¼	6 — 6⅛	6⅛	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	..	..	..	..	6 — 6⅛	6 — 6¼	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	100	..	..	..	104 —107	104 —107	..	..
90,000	Do. do. do. 4% Debenture Stock ..	5	12%	10%	10%	10½— 11½	10½— 11½	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	Stock	..	..	..	101 —104	101 —104	..	..
49,840	Do. do. do. 6% Pref.	3	..	..	..	1⅞— 2⅛	1⅞— 2⅛	..	..
250,000‡	Do. do. do. 4% 1st Mort. Deb. Stock Red	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	Stock	..	..	..	97 —100 xd	97 —100 xd	..	..
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	10	6%	6½%	7½%	17 — 18	17 — 18	17¼	17⅛
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	5	..	..	..	4⅛— 4⅜	4⅛— 4⅜	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	..	..	..	..	110 —114	110 —114	..	..
10,852	Notting Hill Electric Lighting	Stock	..	..	..	96 — 99	96 — 99	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	10	7%	6%	6%	12½— 13½	12½— 13½	..	..
20,000	Do. do. do. 7% Pref. 20,081 to 40,080	5	14½%	14½%	14½%	14— 15⅝	14½— 15⅞	14⅞	14⅝
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	5	..	..	..	7⅛— 8⅛	7⅛— 8⅛	..	..
12,000	Smithfield Markets Electric Supply, Ord.	100	..	..	..	98 —101	98 —101	..	..
50,000	Do. do. do. 4% Deb. Stock	5	..	..	2½%	3 — 3½	3 — 3½	..	..
65,000	South London Electricity Supply, Ord.	Stock	..	..	..	85 — 90	— —	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	12½%	3⅛— 3⅜	3⅛— 3⅜	..	..
80,000	Do. do. 5% Cum. Pref.	5	..	..	..	4⅛— 4⅝	4⅛— 4⅝	5	..
110,000	Westminster Electric Supply, Ord.	5	..	..	..	4⅛— 5⅛	4⅛— 5⅛	5	4⅛
28,141	Do. do. 5% Cum. Pref.	5	10½%	10½%	12%	12 — 13	12 — 13	12⅛	12½
		5	..	..	..	6 — 6¼	6 — 6¼	6⅛	..

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Monday, December 21st.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	,, Nitric	per cwt.	22/-	..
a	,, Oxalic	per cwt.	32/-	..
a	,, Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	,, ,, ...	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90%)	per gal.	7/-	..
a	,, (50/90%)	per gal.	5/6	..
a	Copper Sulphate	per ton	£20	..
a	Lead, Nitrate	per ton	£24	..
a	,, White Sugar	per ton	£31	..
a	,, Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	3d.	..
a	,, Caustic (75/80%).. ..	per ton	£24	..
a	,, Bisulphate	per ton	£35	..
a	Shellac	per cwt.	286/-	..
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	,, Recovered	per ton	£5 10	..
a	,, Lump	per ton	£5	..
a	Soda, Caustic (white 70%) ..	per ton	£10 15	..
a	,, Crystals	per ton	£3	..
a	,, Bichromate, casks.. ..	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	,, Wire, in ton lots ..	per ton	£168	..
b	,, Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £130	..
c	Brass (rolled metal 2' to 12') basis	per lb.	6¾d.	..
c	,, Tube (brazed)	per lb.	8¾d.	..
c	,, ,, (solid drawn).. ..	per lb.	7¼d.	..
c	,, Wire, basis..	per lb.	7d.	..
c	Copper Tubes (brazed)	per lb.	9¼d.	..
c	,, ,, (solid drawn) ..	per lb.	9¼d.	..
g	Copper Bars (best selected ..	per ton	£71	..
g	Copper Sheet	per ton	£71	..
g	,, Rod	per ton	£71	..
c	,, (Electrolytic) Bars ..	per ton	£63	..
c	,, ,, Sheets ..	per ton	£73	..
c	,, ,, Rod ..	per ton	£75	..
c	,, ,, H.C. Wire	per lb.	7¾d.	..
f	Ebonite Rod	per lb.	3/8	..
f	,, Sheet	per lb.	3/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	3/-	..
h	India-rubber, Para fine	per lb.	3/10½ to 3/11	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	,, Pig (Cleveland warrants)	per ton	41/6	..
i	,, Forgings, according to size	per ton	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	..
i	,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£11 12 6 to £11 15	..
g	,, ,, Sheet	per ton	£18	..
m	Manganin Wire No. 28	per lb.	3/-	..
g	Mercury	per bot.	£8 5	..
d	Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d	,, ,, ,, medium	per lb.	2/6 to 3/9	..
d	,, ,, ,, large ..	per lb.	4/- to 7/9	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p	,, rolled bars & rods	per lb.	1/- to 1/3	..
p	,, ,, strip & sheet	per lb.	From 1/1	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 11d.	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	,, ,, in bars	per ton	£15 to £40	..
g	Tin, Block	per ton	£182 to £183	£1 inc.
g	,, Foil	per lb.	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/8	..
p	White Anti-friction Metals—			
	"White Ant" brand ..	per ton	£42 to £62	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	,, 6 lea. Flax	per lb.	6¾d.	..
j	,, 8 ply 10 lbs. Russian ..	per lb.	4½d.	..
j	,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j	,, 180 lbs. Jute rove	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23 15	..

Quotations supplied by Messrs.:—a G. Boor & Co.; b The British Aluminium Co., Ltd.; c Thos. Bolton & Sons., Ltd.; d F. Wiggins & Sons.; e Frederick Smith & Co.; f India-Rubber, G.P. and Teleg. Works Co., Ltd.; g James & Shakspeare; h Edward Till & Co.; i Bolling & Lowe; j Walter H. Hindley and Co., Ltd.; k Morris Ashby, Ltd.; m W. T. Glover & Co., Ltd.; n P. Ormiston & Sons; o Johnson, Matthey & Co., Ltd.; p The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Dec. 12	1,079	+270	—	34,896	+ 6,026	10	—
Birmingham	,, 12	4,894	+342	—	253,984	+10,058	32½	—
Bournemouth ..	,, 16	805	—	—	—	—	10½	—
Blackburn	,, 12	787	+139	—	31,709	+ 1,030	13½	—
Blackpool	,, 17	262	+ 2	—	37,316	— 144	8½	—
,, —Fleetw'd	,, 12	159	+ 17	—	20,375	— 108	7½	—
,, —Lytham	,, 10	128	+ 22	—	860	+ 429	7½	—
Bolton	,, 18	1,660	+201	—	68,207	+ 8,159	25	—
Bradford	—	—	—	—	—	—	41	+4
Brighton	,, 13	721	+ 93	—	34,057	—	7½	—
Bristol	,, 18	4,425	+ 81	—	—	—	28	—
Burnley	,, 12	746	+118	—	—	—	7½	—
Barnsley District	,, 11	146	—	49½	6,843	— 1	4½	—
Devonport ..	,, 11	468	+129	49½	22,793	+ 1,593	5	—
Dudley—Sto'rb'ge	,, 11	715	+ 77	49½	41,148	+ 3,886	18½	—
Gateshead ..	,, 11	843	+ 48	49½	43,346	+ 5,415	10½	+ ½
Gr'o'k + Pt. Glasgw	,, 11	494	+ 85	49½	26,940	+ 2,287	7½	—
Hartlepool ..	,, 11	295	+ 38	49½	13,939	+ 893	6½	+2
Kidderminster ..	,, 11	93	+ 7	49½	6,269	+ 188	4½	—
Middleton	,, 11	224	+ 22	49½	15,557	+ 1,890	5½	—
Oldham—Ashton	,, 11	474	+ 8	49½	27,975	+ 1,609	8	—
Peterborough ..	,, 11	102	— 46	—	7,205	—	7	—
Poole	,, 11	213	+ 50	49½	14,886	+ 2,135	6½	—
Potteries	,, 11	1,566	+ 86	49½	78,438	+ 3,640	28½	—
Southport	,, 11	224	+ 38	49½	15,897	+ 2,685	5½	—
South Staffs. ..	,, 11	934	+382	49½	45,496	+ 8,401	31½	—
Swansea	,, 11	450	+ 51	49½	25,577	+ 2,164	5½	—
Tynemouth	,, 11	181	— 3	49½	15,227	+ 761	9½	—
Wolverhampton..	,, 11	929	+ 35	49½	19,170	+ 1,709	10½	+2

British Elec. Tract. Co.

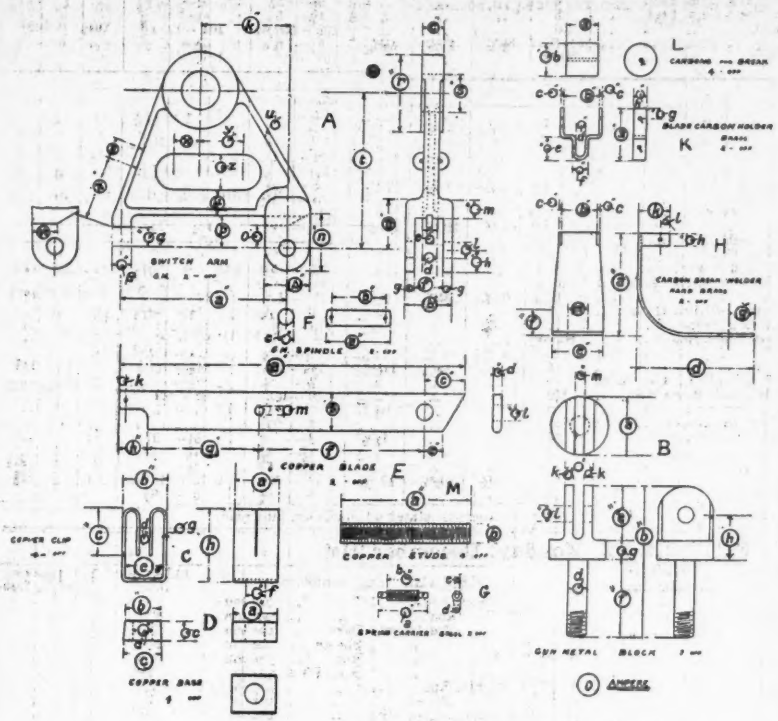
* Compared with the corresponding period of 1902.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
B.E.T. Co.—*cont.*								
Yorks. Wool Dist.	Dec. 11	448	—	42½	16,600	—	6	—
Miscellaneous ..	,, 11	606	—	—	45,244	—	—	—
Burton-on-Trent ..	,, 13	291	—	—	6,910	—	7·25	—
Cardiff	,, 14	1,913	+467	—	72,973	+19,911	14	—
Chatham & District	,, 12	486	+197	—	26,471	+14,058	8·53	—
Cork	,, 17	389	— 2	—	25,798	— 3,370	9	—
Dover	,, 10	176	+ 27	—	10,895	+ 82	2½	—
Dublin	,, 12	4,334	+421	—	121,517	+ 8,131	45½	+ ½
East Ham	,, 13	463	+152	—	24,958	+7,231	5	+ ½
Glasgow	,, 12	13,582	+3066	—	383,044	+40,188	69½	+7½
Halifax (2 weeks) ..	,, 16	2,092	+210	37	51,276	+ 5,741	31½	+1½
Hull	,, 2	1,822	+209	—	69,295	+ 4,066	11½	+1
Ilkeston	,, 16	114	—	—	—	—	4	—
Isle of Thanet ..	,, 10	213	+ 10	—	32,735	— 1,589	10½	—
Leeds	,, 12	4,229	+490	—	204,877	+12,604	41	—
Liverpool	,, 12	9,917	+285	—	492,774	+16,255	108	—
London C. C. ..	,, 12	8,908	+1895	36	365,961	+68,842	39½	—
Manchester	,, 5	10,737	+3287	—	432,686	+253,584	72	—
Newcastle	,, 12	3,483	+508	—	—	—	17	—
Portsmouth	,, 12	1,287	+227	—	67,276	+ 4,177	14½	—
Salford	,, 14	3,741	+959	—	141,789	+41,736	30	—
Southampton ..	,, 17	814	+ 17	—	—	—	16½	—
Southend-on-Sea ..	,, 16	196	+ 36	37	13,617	+ 2,036	8	—
Sunderland	,, 12	998	+ 26	—	45,780	+ 2,163	20	+3
Cen. London Rly. ..	,, 12	7,054	—275	—	159,154	— 7,185	6	—
City & S. Lon. Rly. ..	,, 20	3,070	—229	25	67,715	—10,138	5½	—
Dublin—Lucan Rly. ..	,, 18	82	+ 7	—	3,022	+ 180	6½	—
L'pool Overh'd Rly. ..	,, 13	1,512	+143	—	19,762	+ 2,665	6½	—
Mersey Railway	,, 12	1,304	+284	24	31,889	+ 6,967	4½	—

SWITCH CONSTRUCTION.

By N. C. WOODFIN.

It is, perhaps, a matter of some surprise that good knife switches are not yet universally used for controlling the ordinary circuits of lamps and motors from 15 amperes upwards.



Details of D.P. Switch. No Scale.

The accompanying figures illustrate a recently designed single knife switch, in which simplicity and effective working have been aimed at. It is intended also that the drawings, together with specimens of time-sheets, should afford a means of ascertaining the net cost of production. By net cost is meant labour and material, other charges having to be estimated according to various rules. We shall consider the design of a double-pole switch. This may be produced in small quantities with the aid of a milling, a drilling machine, and a few lathes. First of all, let there be chosen suitable ranges which will fix the number of sizes required.

We may take 15 amperes, 25 amperes, 50 amperes, 100 amperes, 200 amperes, 400 amperes, and 600 amperes. Select 250 volts as the maximum working potential difference for which the designs here given are to be used, and then let the minimum distance between the contacts and between the furthest contact and the blade when broken be 2½ in.

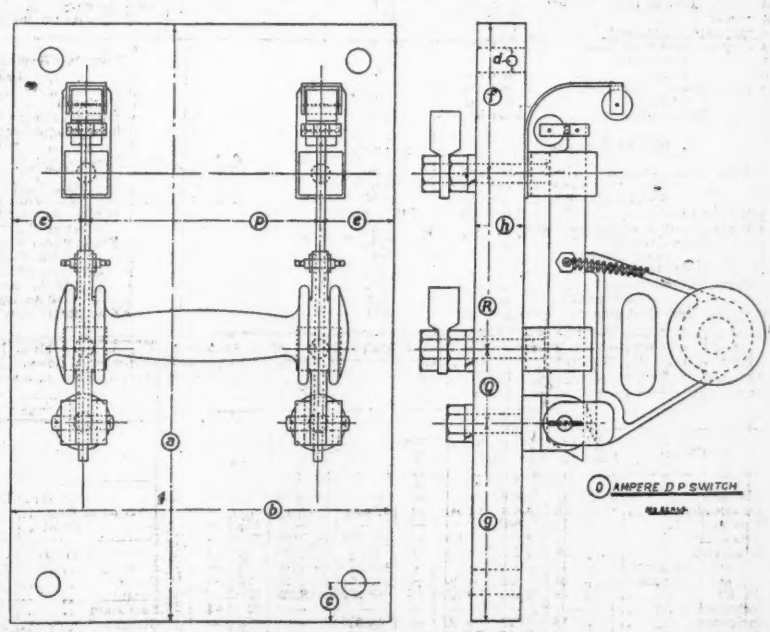
For 500 volts this distance needs to be doubled, and longer blades, longer slates and longer pattern switch arm castings will be required.

Next one must decide upon suitable current densities for the various parts of the switch: let the blades, contacts and studs be all of copper. Allow 1,000 amperes per sq. in. at the bottom of stud thread for Whitworth screw. Allow 500 amperes per sq. in. in the blade and contacts. Allow 50 amperes per sq. in. at the surface of the contact where the clip embraces the blade.

One of the principal castings needed will be the switch arm to which the handle is attached, and the latter may as well be selected first. Unless there is special wood working machinery or convenient apparatus for the production of insulating handles, it will be best to get these from manufacturers of insulating material, some of whom make a speciality of switch handles. There may still be seen a great many double-pole switches with their connecting levers made of red fibre, with a handle of dark wood stuck straight out from the middle. This has the appearance of a patched piece of work. Why not make the double-pole switch a complete design in itself? In most installations where single-pole switches are used for currents upwards of 10 amperes, it would be far better to have double-pole switches.

Accordingly, select a horizontal handle of ambroin (see next page). This material is used very largely for switch handles now, combining as it does a fair amount of mechanical strength with good insulating qualities, and being much cheaper than vulcanite. Ambroin apparently is not suitable for small insulating rods such as those of about ½ in. diameter, because it is a material which is moulded to shape, and has the drawback that it is almost impossible to machine. It will serve for 50-ampere switches and upwards. For the two smaller sizes use a piece of ⅝ vulcanite rod with screwed ends passing through the castings, which are embraced by vulcanite flanges.

Beginning with the 50-ampere size, there should be made a complete drawing showing the general arrangement and details for a double-pole switch; tracings are then prepared, having no numbers marked for the dimensions, but only blanks. From the tracings a number of blue prints are obtained; on the first the dimensions are all marked with small letters of the alphabet. A table is then made (see Table I.); this with the letter-marked print provides a ready means of comparison and reference for the sizes of all the switches. It will now only be necessary to make general arrangement drawings of the other sizes of switches, and with



General Arrangement of D.P. Switch.

Table I.—Dimensions of Switches in Inches.

Detail A. Gun-metal switch arm.	Letter.	Range in amperes. 15	25	50	100	200	400	600
	a	2 1/4	2 5/8	3 1/4	3 5/8	4 7/16	5 7/8	7 1/16
	b	7/16	1/2	15/16	1	1 1/4	1 5/16	1 5/8
	c	5/16	3/8	7/16	7/16	1/2	5/8	1
	d	3/16	1/4	3/16	5/16	3/8	1/2	5/8
	e	3/32	3/32	1/8	9/16	5/16	13/16	1 1/8
	f	1/32	3/32	3/16	3/16	1/4	1/2	3/4
	g	1/32	1/32	1/16	1/8	1/4	1/4	1/4
	h	1/8	5/16	7/16	9/16	5/8	3/4	1 1/8
	k	1 1/4	1 1/2	1 3/4	2 1/4	2 3/4	3	4
	l	1/16	1/4	1/16	1/8	1/16	1/2	5/8
	m	1/4	1/4	3/8	3/8	7/16	7/8	1
	n	1/4	3/4	1 1/8	1 1/2	1 7/8	2 5/8	3 1/2
	o	5/16	7/16	7/16	1 1/16	1 5/16	1 7/8	2 1/2
	p	3/16	1/4	3/8	1 1/16	1 5/16	1 3/4	2 1/2
	q	3/4	1	1 1/2	1 1/2	2 1/2	3	4
	r	3/4	3/4	3/4	3/4	1	1	1
	s	2 3/16	2 5/8	3	3 7/8	4 3/4	5 1/4	6 1/16
	t	1/16	1/8	1/8	1/8	1/8	1/8	1/16
	u	1/16	3/32	1/8	1/8	1/8	1/8	1/8
	v	3/8	3/8	7/16	5/8	1	1	1 3/8
	w	1/4	1/2	7/8	1 1/16	1	1 1/2	1 7/8
	x	3/8	5/8	11/16	7/8	1 1/4	1 1/2	1 1/2
	y	5/16	3/8	1/2	1 1/16	1 1/2	1 1/2	2
	z	3/16	1/16	1/16	3/8	3/8	3/8	1/2
	π	9/16	11/16	1	1 1/16	1 1/2	2	2 1/2
	φ	1/4	3/8	7/8	1 1/16	1 1/4	1 1/2	1 7/8
	θ	1/8	1/8	1/8	1/8	1/8	1/8	1/8
	β	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Δ	3/8	3/8	1/2	1/2	1/2	1/2	3/4
	μ	9/16	7/16	5/8	7/8	1 1/16	1 1/8	1 3/8

Gun-metal. Block B								
	a	3/8	1/2	1 1/8	1 1/4	1 1/2	2 1/8	2 1/4
	b	1 1/16	2	2 1/16	3 9/16	4 3/8	8	10 1/2
	c	1/4	3/8	9/16	5/8	3/4	1 1/16	1 1/8
	d	3/16	3/8	1/2	1/2	3/8	3/8	1/2
	e	1/2	3/4	1 1/16	1 5/16	1 3/4	2 7/16	4
	f	1	1 1/8	1 1/2	1 3/4	2 1/4	4 1/4	5
	g	3/16	3/8	3/8	1/2	3/8	3/8	1 1/8
	h	1/2	3/4	7/8	1 3/16	1 5/8	2 1/4	3
	k	3/16	1/4	3/16	1/4	1/4	1/2	1/2
	l	3/16	1/4	3/16	1/4	1/4	1/2	1/2
	m	3/32	1/4	1/16	1/8	1/8	1/8	13/32

Copper clip C.	Letter.	Range in amperes. 15	25	50	100	200	400	600
	a	1/2	5/8	7/8	1 1/8	1 1/2	*	*
	b	7/16	9/16	7/8	1 3/16	1 1/2	—	—
	c	1/2	5/8	29/32	1 1/8	1 7/16	—	—
	d	3/16	3/16	3/16	5/16	9/32	11/32	13/32
	e	3/8	1/2	3/4	1	1 1/4	—	—
	f	3/16	1/4	1/8	1/2	5/8	—	—
	g	1/32	.04	1/16	3/32	1/8	—	—
	h	3/4	1	1 13/32	2	2 11/16	3 3/4	5 1/8
	k	3	4	5 1/2	8 1/2	10 5/8	—	—
	Δ 1	510	570	470	480	560	425	415
	D 1	72	67	59	71	86	—	—

* Use block B. but of copper.

Copper base D.								
	a	1/8	5/16	7/8	1 1/8	1 1/2	—	—
	b.	3/8	1/2	1 1/16	1 5/16	1 1/8	—	—
	c	3/8	1/2	3/4	1	1 1/2	—	—
	d	3/16	1/4	3/8	1/2	5/8	—	—
	e	3/16	1/4	3/8	1/2	5/8	—	—
	θ_{11M}	117	110	97	108	136	146	170

Copper blade E.								
	a	4 13/16	5 9/16	6 3/4	7 3/4	9 9/16	12 1/2	15 1/8
	b	3/8	1/2	3/4	1 1/16	1 1/4	2 1/8	3 1/2
	c	1/2	9/16	3/4	1 1/16	1 9/16	2 1/8	3 1/2
	d	3/32	3/32	3/16	3/16	3/32	5/16	3/8
	e	1/4	9/32	11/32	7/16	11/16	5/8	1
	f	2 1/2	2 5/8	3 1/4	3 5/8	4 7/16	5 7/8	7 1/16
	g	1 3/4	1 13/16	2 3/16	2 7/16	2 13/16	3 3/8	3 9/16
	h	5/16	7/16	9/16	5/8	3/4	1 1/8	1 3/8
	k	1/8	1/4	5/16	3/16	1/4	1/4	3/8
	l	3/16	1/4	5/16	3/16	1/4	1/4	3/8
	m	1/8	1/8	5/16	3/16	1/4	1/4	1/4
	/	.05	.05	.05	.05	.05	1/8	1/8
	Δ 11	427	534	350	500	480	510	460
	θ_{11}	43	42	42	43	48	40	43

Gun-metal spindle F.	Letter.	Range in amperes. 15	25	50	100	200	400	600
	a	5/8	7/8	1 1/4	1 3/4	1 5/8	2	2 1/4
	b	1/2	1/16	1/16	1 3/16	1 3/8	1 1/2	1 13/16
	c	3/16	1/4	5/16	3/8	7/16	1/2	5/8
	/	1/16	1/16	3/32	3/32	3/32	1/8	1/8

Steel spring. Carrier G.								
	a	3/4	3/4	1	1 1/8	1 1/4	1 5/8	1 5/8
	b	3/8	3/8	1/4	3/4	3/4	1	1
	c	3/32	3/32	1/8	1/8	1/4	1/8	1/4
	d	1/8	1/8	3/16	3/16	1/4	3/8	3/8
	/	.04	.04	.05	.05	.05	.07	.07

Carbon break-holder H. Brass.								
	a	1 3/8	1 13/16	2	3 1/8	4 1/8	6 1/4	8 1/2
	b	3/8	1/2	1/16	3/4	7/8	1 1/8	1 5/8
	c	1 5/16	1 11/16	2 5/16	2 3/8	2 7/8	4 9/16	4 5/8
	d	1/2	5/8	1	1 1/8	1 1/2	2 1/8	2 1/8
	e	—	—	1/2	1/2	1/4	3/4	1
	f	1/4	5/16	1/16	1/16	1/16	1 1/16	1 1/8
	g	3/16	5/16	1/8	1/8	1/16	1/2	3/4
	h	3/32	1/4	1/8	1/16	1/16	1/4	1/8
	k	3/32	1/4	1/8	1/16	1/16	1/4	1/8
	l	3/16	1/2	3/8	1/2	5/8	7/8	1 1/8
	m	05	05	05	05	1/16	1/8	1/8

Blade carbon holder K. Brass.								
	a	9/16	3/4	1	1 3/16	1 9/16	2 5/8	3 1/4
	b	3/8	1/4	1/16	3/4	1/8	1 1/8	1 5/8
	c	1/16	1/16	1/16	1/16	1/16	1/8	1/8
	d	3/32	3/32	3/16	3/16	9/32	1/8	3/8
	e	1/4	5/16	7/16	1/4	13/32	1/8	1/2
	f	7/32	7/32	5/16	5/16	13/32	9/16	5/8
	g	3/32	1/8	3/16	3/16	1/4	1/8	3/8
	h	3/16	3/16	1/4	1/4	5/16	1/2	3/4
	/	05	05	.05	.05	1/16	1/8	1/8

Carbons L.								
	a	3/8	1/2	5/8	1 1/16	3/4	1 1/2	1 1/2
	b	3/8	1/2	5/8	5/8	3/4	1 1/2	1 1/2
	/	1/16	1/16	1/16	1/16	3/32	5/32	5/32

Copper stud M.								
	a	1 1/2	1 3/4	2 5/8	3 1/2	3 3/4	4 1/2	5
	b	3/16	1/4	3/8	1/8	5/8	7/8	1 1/8
	Δ 11	1,060	925	730	1,050	985	950	860

Brass nut N.	—	3/16	1/4	3/8	1/2	5/8	7/8	1 1/8

Steel cotter pin O.								
	a	3/8	1/2	3/4	3/4	7/8	1	1 1/4
	b	1/16	1/16	3/32	3/32	3/32	1/8	1/8

Plate or marble base S.	Letter.	Range in amperes. 15	25	50	100	200	400	600
	a	8 1/2	10	12	14	16 1/2	20	24
	b	5	5 3/4	7 3/4	9	10	11 1/2	12
	c	5/8	5/8	3/4	3/4	1	1	1
	d	3/8	3/8	1/2	1/2	1/2	1/2	1/2
	e	3/4	7/8	1 1/2	2 1/2	2 19/32	3 1/32	3 1/16
	f	2	2 3/8	3	3 1/2	4	5	6
	g	2 3/4	3 3/8	4	5	5 3/4	6 3/4	8 1/2
	h	5/8	3/4	1	1	1 1/4	1 1/2	2
	P	3 1/2	4	4 1/2	4 3/4	4 13/16	5 7/16	5 7/8
	Q	3/4	1	1 1/8	1 1/2	2 3/8	3 1/4	4 3/8
	R	3	3 1/2	3 1/2	3 3/4	4 1/8	4 3/4	4 7/8

		15	25	50	100	200	400	600
Nut for **G** detail **U**		1/8	1/8	3/16	3/16	1/4	3/8	3/8
Size spring **V**		I.	II.	III.	IV.	V.	VI.	VII.
Grover washer **W**		3/16	1/4	3/8	1/2	5/8	7/8	1 1/8
Socket **X** { Hole		3/16	1/4	3/8	1/2	5/8	7/8	1 1/8
Socket **X** { Cable		17/32	13/16	13/16	13/16	27/32	61/32	61/32
Socket **X** { Cable hole ...		3/16	1/4	3/8	1/2	5/8	1	1 1/2
Phosphor bronze		—	—	—	—	—	—	—
Spindle **Y** for **L**		.05	.05	.05	05	1/16	1/8	1/8
Gross length		9/16	11/16	15/16	1	1 3/16	1 3/4	2
Rivet **Z** length		1/4	1/4	3/8	3/8	1/2	5/8	3/4

Note.

C *k* = length copper strip for clip unbent.
Δ_{11} = density in amperes per sq. in. at smallest section.
θ_{11} = density in amperes per sq. in. at contact.

Note.

P = distance between centres of opposite poles.
Q = " " " contact and Block **B**.
R = " " " contacts **C**.

Each contact to be sweated together **C D M**

Handle T.

15 and 25-amp. 5/8-in. ebonite rod × 1 3/4-in. flange.
50—200-amp. ambroin **D G**, No. 831, No. 372 **B**.
400-amp. " " " " 374 **B**.
600-amp. " " " " 376

these and the 50-ampere standard suitable dimensions may be fixed for all sizes, after determining a few figures for certain parts according to the rules first laid down for current density.

Having completed Table I., when detail drawings are required for the purpose of making the parts of any switch of the selected ranges, a standard blank blue print is taken,

Table II. — Sheet No. 1,001.

Workman's No. 21. — Time—Hours & Qrs. — Date—June 30.

Detail. Name.	Letter.	No. Articles	Works Or. No.	Tr. No.	Grinding.	Milling.	Turning.	Drilling.	Tapping.	Slotting.	Filing.	Sundries.	Total.	Remarks.
Stud	M	24	502	12			½		1½				2	
Block	B	12	502	12			3	1	1	2	½		7½	

Day's time—Hrs. 9½.

Foreman's Signature

and the series of figures needed filled in from this table of reference. The tracing is marked "No scale," meaning that it is not necessarily to scale, but that the marked dimensions only must be used. Table II. shows a specimen of the daily time-sheet in use, and Table III. illustrates the type of cost-sheet kept for each article in the office, and regularly filled up from Table II. until the article is completed.

The drawing shows the numbers of details required for one double-pole switch. The first portion of Table II., which is the time-sheet also, serves as a workshop order which may be served out to each person before closing time for the following day. It will be observed that every part of the switch has some capital letter assigned to it; the convenience of this in using the tables will be recognised. For various purposes small articles of manufacture have to be identified from time to time, and this identification in some places is occasionally a matter of difficulty. With the system here outlined everything made has a name, a letter, and a number, and is at once shown up by reference to the

Table III. — Sheet No. 101.

Works Or. No. 502 — Time—Hours. — Date. — Started. — Finished.

Detail. Name.	Letter.	Tracing No.	Workman's No.	Rate per hour.	H. Sheet No.	Grinding.	Milling.	Turning.	Drilling.	Tapping.	Slotting.	Filing.	Total time.	Material.	Weight. lbs.	Price per lb.	Remarks.
					1,020			9					9				
		12	21	3	1,021			9					9				
Block	B				1,022				6			3	9	Gun-metal	36	10	
					1,023					6	3		9				
					1,024						9		9				
													43				

No. Articles.	Cost labour each.	Cost material each.	Net cost.
72	$\frac{9 \times 45}{72} = 5d.$	$\frac{36 \times 10}{72} = 5d.$	10d.

drawing; the letter and drawing number should be stamped on the article where practicable, which it is generally. A sheet, Table III., must be filled up for each detail; all are filed together belonging to one order number and then passed into the superior office where they are entered up on a sheet like Table IV.

In the arrangement of the switch a rolling carbon break is illustrated; for the smaller sizes the carbon contacts may be made out of disused arc lamp carbons; they are supported on phosphor bronze pins riveted over at the ends.

No extra holes in the base are required, and a plain switch may have a carbon break added to it by merely changing the blade to one with a carbon-holder and slipping the other holder under the copper clip, the stud of which holds both of these. Above 200 amperes the bent clip form of copper contact cannot very well be used, as the thickness necessary to carry the current is so great as to prevent convenient bending, apart from the unwisdom of leading heavy currents around the circuitous path of the U, it being inadvisable to use strip more than ½ thick. In the larger sizes, therefore, a copper block like the switch block, B, may be used, the top of the contact being, of course, square, not round, but having all corners bevelled and three saw cuts in each arm of the fork.

In the process of manufacture, after patterns have been made for the castings required, prints with only those dimensions marked which are needful for machining should be issued, and on the standard chart of dimensions mounted in the drawing office, it would be a good plan to mark those for machining in a different colour from those for pattern-making. In the switch illustrated the blade makes an angle of 60° with the base when open, and is then "dead," being just clear of the contacts. In the table of dimensions the actual current densities at different parts of the switch are given. The limits laid down at first are slightly exceeded in certain parts, but in most places are not quite reached. The limit of 500 amperes per sq. in. of copper is probably liberal, but not more so than it should be in the case

Table IV — Sheet No. 11.

Works Or. No. 50 — Type 0. — Date finished

Description. — 2 Dm. 50-amp. D.P. Switches. — Dg. No. 5.

Details.	Letter.	Net cost.	III. sheet No.	No. wanted per switch.	Net cost per switch.
Switch arm	A		100		
Block	B		101	2	
	C				

Net cost each switch =

Add % fixed charges =

Sale price =

of switches, and 1,000 amperes per sq. in. is only reached at the bottom of the screw thread of the studs. There are firms now making and selling switches that sometimes exceed the limits set forth, and at the same time use brass of an inferior quality instead of good copper. Current densities in switches are somewhat guess work, because few people will go to the trouble and expense of making heating tests of switchboards, while very seldom any weakness is manifested, because full load is so rarely reached in the vast number of installations put down in recent years.

THE DESIGN OF DIRECT-CURRENT MACHINERY.

By VAL. A. FYNN.

(*Continued from page* 933.)

We now pass on to the consideration of the details of calculation of the magnetic circuit. The writer has been in the habit of using printed forms for this work, which, although they may at first sight seem rather elaborate, have proved of the greatest use. It well repays the small trouble involved to obtain, once at least, the full picture of the conditions in every part of the machine. The possibility of subsequent adaptations to altered conditions can then be surely and quickly estimated by reference to this original calculation.

DESIGN OF DIRECT CURRENT MACHINERY.

V. A. FYNN. 3/6

Type of Machine.

Drawing reference = Order No. =

Manufacturing No. =

Motor, Generator. Armature Winding order =

Magnet " " =

Output: Volts: Amperes: Revs:

For whom:

Magnetic Circuit.

Armature outer diam d_1 = =

" total length = = + gap + endplates

" iron gauge = B W G =

" paper thickness = =

" useful length = =

Number of slots =

Dimensions of finished slot =

Outer circumference c_1 = × 3·14 =

" pitch P_1 =

Pitch diam d_2 =

c_2 = × 3·14 =

P_2 =

Slot bottom diam d_3 =

Inner armature diam (magnetic) = =

Slots under pole =

Alteration of Air Width = =

= =

Air width =

" length =

Air Section =

Mechanical Air gap total =

Magnetic " " " = =

Useful Leakage coefficient = =

Sections between Slots

= + % =

= + % =

Section behind Slots = =

V. A. F. 3/6

Transition Section. Pole to Disc = =

" " Disc. to C. I. = =

= =

= =

" " C. I. to C. I. = =

Frame Section = =

" " = =

Pole dimensions = =

" " = =

" " = =

Pole Shoe Area = =

Pole Section = =

Length of Magnetic Paths

Between Slots	L_1	=	cm Q,	=	cm² V,	=	Q, =	m²
		=		=		=	=	
Behind Slots	L_2	=		=		=	=	
In air	L_3	=		=		=	=	
Pole shoe	L_4	=		=		=	=	
		=		=		=	=	
Pole	L_5	=		=		=	=	
"	L_6	=		=		=	=	
Pole to Disc	L_7	=		=		=	=	
Disc to C. I.		=		=		=	=	
Frame	L_8	=		=		=	=	
"		=		=		=	=	
Frame	L_9	=		=		=	=	

Armature Winding

Nature of winding =

No. of Com. Sections =

Wires per Slot =

Micanite troughs =

Wire gauge and insulation = W G

" Diameter = mils = m/m

" Section = m/m²

" Load = amperes per m/m²

Res. per 1000 Ft. at 122° F. =

Weight per 1000 Ft. =

Projection of windings (pulley end) = (comr. end) =

V. A. F. 3/6

Mean length of turn =

Total number of turns =

Total length =

" resistance + 5% =

Resistance per circuit =

" between brushes =

Volts lost in armature =

Volts lost through brushes, com. and leads = } Total volts lost =

Watts lost in armature =

Weight + 10% =

Characteristics

Volts =

L_1 =	cm Q, =	cm² Lines =	AT =	}	=
	" =	" =	" =		
L_2 =	" =	" =	" =		=
L_3 =	" =	" =	" =		=
L_4 =	" =	" =	" =	}	=
	" =	" =	" =		
L_5 =	" =	" =	" =		=
L_6 =	" =	" =	" =		=
L_7 =	" =	" =	" =	}	=
	" =	" =	" =		
L_8 =	" =	" =	" =	}	=
	" =	" =	" =		
L_9 =	" =	" =	" =		=
					=

Reaction

Total ampere turns per pole pair

Per pole

Polar embrace =

A. T_a =

A. T_m =

A. T_f =

Load =

V. A. F. 3/6

Field Winding for = Volts

Shunt. Width of Coil = = cm.

Parallel height = × 1·1 = "

Conical " = × 1·1 = "

Diam in mils = √ = = √ =

Nearest wire gauge and insulation =

Wire diameter = mils = m/m

" " = " = "

" Section = m/m² = m/m²

" Load = amps per m/m² = a.p. m/m²

Res. per 1000 Ft. at 125° F. =

Weight per 1000 Feet =

Parallel Coil. No. of layers =

" " Turns per layer =

" " Total turns =

" " Mean length of turn =

" " Total length =

" " Total Resistance + ... % =

Conical " No of layers =

" " Turns per layer =

" " Total turns =

" " Mean length of turn =

" " Total length =

" " Total Resistance + ... % =

Turns per spool (Total) =

Resistance + ... % per spool (total) =

Amperes flowing =

" required =

(max) Watts lost per spool =

(min) " " " =

Total watts lost =

Weight per spool + 10% =

Total Weight + 10 % =

Main

Amperes flowing =

Ampere turns required =

No. of turns per spool (useful) =

Space for main turns =

Wire gauge, dimensions =

We give herewith the specifications referred to, and will deal with the various points in the sequence observed thereon, which closely corresponds to the order in which it is convenient to take them in practice.

The predetermination of the "air section" and the length of the air path is obviously of the greatest importance, since on the value of these two items depends the greatest number of ampere-turns required for the whole circuit.

V. A. F. ⅔

Insulation —
Wire section — m/m²
Wire load — amps. per m/m²
No. of layers —
Turns per layer (actual) —
No. in parallel —
Res. per 1000 feet at 125° F —
Weight per 1000 feet —
Mean length of turn —
Length per spool —
Resistance per spool + 5 % —
Total resistance „ —
Volts lost per spool —
Total Volts lost —
Watts lost per spool —
Total Watts lost —
Weight per spool + 10 % —
Total weight + 10 % —

Armature laminations losses and weights

Outer diam — — Area —
Pitch diam — — „ —
Slot bottom diam — — „ —
Inner magnetic — — „ —
Inner diam — — „ —
Area of a slot — „ —
Total area of slots — „ —
„ „ between slots — „ —
„ volume „ „ — „ —
„ weight „ „ —
Lines —
Area behind slots —
Volume „ „ —
Lines „ „ —
Total weight behind slots —
„ „ of stamped discs —
„ volume of unstamped discs —
„ weight „ „ —

V. A. F. ⅔

Iron losses
Hysteresis between slots — —
Foucault „ „ — —
Hysteresis behind slots — —
Foucault „ „ — —
Total watts lost in iron —

Cooling surfaces

Armature copper loss — Watts
iron loss — „
Total loss
Cooling surfaces outer peripheral — —
inner „ — —
side faces — —
Total cooling surface —
Cooling surface per watt lost — —

Commutator friction losses — Watts
„ contact resistance losses — „
Total losses —
Cooling surfaces outside peripheral — —
inside „ — —
side face — —
Total cooling surface —
Cooling surface per watt lost — —

Field coils loss per coil
Cooling surface parallel circumference — —
conical „ — —
outside „ — —
Total cooling surface —
Cooling surface per watt lost — —

Efficiency. Exclusive of bearing friction and ventilation losses.

Excitation losses — Watts
Commutator losses — „
Armature copper loss — „
„ iron „ — „
Total losses —
Output —
Efficiency Full load — — %
½ load — — %
¼ „ — — %
⅛ „ — — % Date:

The conditions are in reality so complicated that it becomes impossible to fully cover all cases by absolutely correct formulæ of a nature allowing of every day use, and it is necessary in order to arrive at expressions which can be easily handled to deal with all secondary effects by means of allowances and the use of a little judgment.

For some years it has been the writer's practice to make use of certain empirical formulæ, based on careful theo-

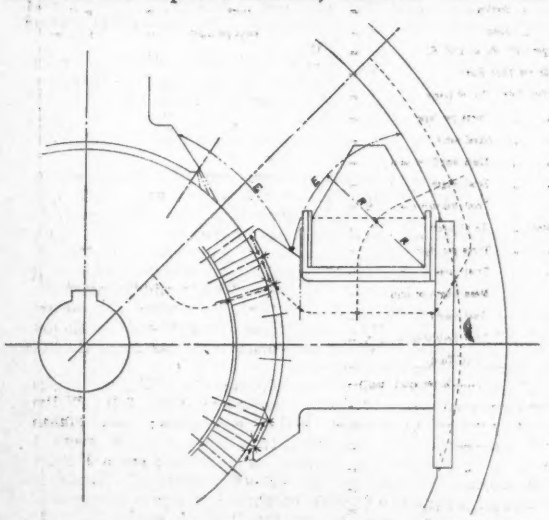


Fig. 17.

retical considerations, and to follow the few rules stated hereafter in order to arrive quickly at a reliable result. He has found this method to meet all cases with sufficient accuracy.

It is convenient to set out, as shown in fig. 17, preferably on as large a scale as possible, the outline of the magnetic circuit showing the slots in their two extreme positions under one pole. The extreme positions are, of course, obtained by assuming that the armature has moved through an angle corresponding to half the slot pitch; one position is shown under one half of the pole face, the other position under the other half. The slots near the pole tips are the only ones which need be fully drawn out, for the rest the indication of their centre line suffices. To obtain a measure of the useful leakage field, we draw the radius touching the pole tip, and from the point where it cuts the armature periphery, we carry lengths of one centimetre to within a short distance of the centre of the interpolar space. The pole tip face is then divided into a corresponding number of equi-distant points, and these being connected in their natural sequence to the points on the armature represent the mean paths of the useful leakage lines, which add to the air area to be taken into account. It is obvious that should one of these centimetre divisions fall on the actual middle point of the interpolar space, it cannot be considered as adding to the useful air section, and no corresponding point should be chosen on the pole tip face. When no pole tip face exists, then the various paths are taken as radiating from the pole tip itself.

Since these lines are supposed to represent the mean lengths of the leakage lines entering the armature on a surface extending half a centimetre on either side of them, it follows that in order to get at the actual number of slots under the pole we only consider the area equal to the polar embrace plus one centimetre. In this way the number of slots under each pole is ascertained for the two extreme positions, and the mean taken for the calculation.

(To be continued.)

TESTING TIRES ELECTRICALLY.

From the Palmer Tyre, Ltd., of 15, Martineau Street, Birmingham we have received a catalogue relating to their Palmer cord motor tires. A description is given of the apparatus employed for producing the new "airless cord" which is used in the construction of these tires.

The accompanying illustration shows an apparatus used in the Birmingham experimental department, which is different from anything of the kind in existence.

If tires are tested on a revolving drum, which is the usual

method, the curvature of the drum reverses the curvature of the fabric every time the wheel revolves, and the result is misleading.

In order that the fabric of the tire may be merely flattened at the tread where it is distorted under load, the company runs two pneumatic-tired wheels together, both inflated to the same pressure. By this means each tire forms the equivalent to a flat road for the other.

The wheel shown on the left-hand side of the illustration (which may be called No. 1) is pressed against the wheel shown on the right-hand side by a lever carrying heavy weights, which are in the pit below the apparatus; this represents the load. The wheel shown on the right-hand side (No. 2) is so arranged that it may be turned upon a horizontal line at right angles to its axle in such a manner that when so turned it revolves in a different plane from wheel No. 1. In order to keep No. 2 wheel steady, its support is attached to a heavy pendulum weighing upwards of 2 tons, which may be seen in the pit below the apparatus.

If this pendulum is caused to rock to and fro while the wheels are revolving, the strains which are set up in the fabric of the tires are similar in character to those which take place in the fabric of motor-car tires when driven rapidly round curves varying in direction.

Two 50-H P. electric motors are employed, both of which may be used either as a motor or as a dynamo. Assuming that No. 1 wheel is driven by No. 1 motor, and that No. 2 motor is disconnected, the apparatus is then "running light," and if the pendulum is stationary in a vertical position, the conditions are then similar to those of tires on a loaded car running on a level road, No. 1 being the driving and No. 2 the front wheel.

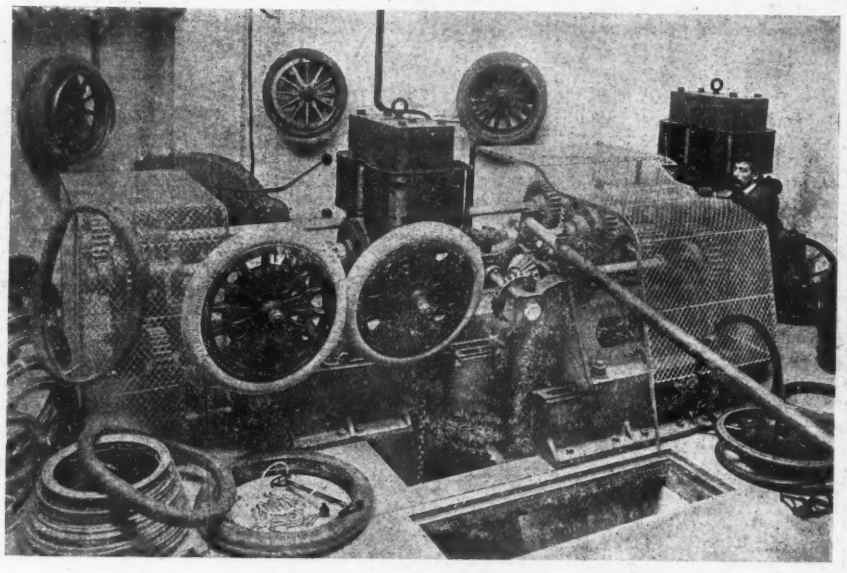
If No. 2 motor is connected as a dynamo, then the conditions at No. 1 wheel are similar to a loaded car going up a very steep hill, and the conditions at No. 2 wheel are like those of a loaded car going down a very steep hill with the brakes fully on.

The switchboard instruments show at a glance how much electrical horse-power is supplied to motor No. 1, and also how much is given out by motor No. 2 being run as a dynamo; and by making allowance for friction of the apparatus, an approximate estimate may be obtained of the power absorbed by the tires, which is very useful in comparing different makes. A series of jets of air directed on to the surface of the tires make the conditions similar to those of a motor-car travelling in the open air.

The number of tests which may be made by this apparatus is almost unlimited.

By switching the electric current from No. 1 motor to No. 2, the whole of the conditions may be reversed, so that the operator can test both tires for a given time under all conditions. The strains which the fabric of the tire may be subjected to by this apparatus are incomparably greater than could possibly be given to the tires under road tests, and this is done without risk to life or limb. If a tire is not torn off its rim when running at high speed on this apparatus with the pendulum moving, it may be safely assumed that it will never come off its rim in ordinary use.

Apart from this explanation of the method of testing the tires, the catalogue will appeal to all who are interested in the motor-car industries because of the description of the tire, and its construction which is contained therein.



Fire Testing Plant, Palmer Tyre Co., Birmingham.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE CITY AND SOUTH LONDON RAILWAY: WORKING RESULTS OF THE THREE-WIRE SYSTEM APPLIED TO TRACTION, &c.

By Peter Valentine McMahon, Member.

(*Abstract of Paper read December 17th*, 1903.)

This line, the pioneer of deep-level railways and of heavy electric traction, was opened for traffic on December 18th, 1890, with terminal stations at Stockwell and King William Street, City, with a total length of 3½ miles. The power house at Stockwell contained three vertical compound engines driving, by link-belts and jockey-pulleys, three Edison-Hopkinson generators having an output of 400 amperes at 500 volts. A fourth engine and generator were added shortly after the opening and, later, a high-speed Willans-Siemens set was put down, which was also the first direct-coupled engine and generator to be used for traction purposes in the United Kingdom. Steam was supplied by eight Lancashire boilers, fed by Vicars mechanical stokers and working at 140 lbs. pressure. In the first year of working 5,261,398 passengers were carried.

With the experience gained in the nine years' working of the railway from Stockwell to King William Street, when the question of additional power for the extensions of the line to Clapham Common and Moorgate Street and the later extension to Islington were considered, it was decided to build a new generating station and to convert the old one into a repair and tool shop. It was also found that to meet the growing traffic it would be necessary to run four-coach instead of three-coach trains as in the past. The lifts on the old line were worked by hydraulic mains from Stockwell. But the problem of transmitting the necessary hydraulic power to Islington involved a radical alteration in the hydraulic plant, and it was decided to use electric lifts on the extension.

With the increased length of line, quicker service, and heavier trains, and with the lifts worked electrically, it was clear that the plain two-wire distribution at 500 volts continuous-current would not meet the case from the point of view either of economy or of the Board of Trade regulations, and it was decided to adopt the continuous-current three-wire system with the rails as the middle wire.

The new generating station* was built on a piece of land adjoining the old boiler house at Stockwell.

The boiler house contains 12 Economic boilers built by Messrs. Davey, Paxman & Co., of Colchester, the rated evaporative duty of each boiler being 8,000 lbs. of steam per hour; and two almost similar boilers by Messrs. Taylor & Sons. The mechanical stokers are of the well-known Vicars type.

Steam is taken from the range of boilers by a duplicate system of steam pipes; both pipes are always in use, and thus in case of accident it is only necessary to shut down the defective main, and no time is lost in heating up a cold main. This arrangement exposes more surface, but the amount of steam piping is reduced to a minimum, and the pipes are smaller.

In the engine house, at present, seven direct-connected sets are installed, varying in output from 125 to 800 KW. With large Corliss engines the sets might have been larger, but with a generator running at 1,000 volts across the outers, a permanent short-circuit on one side of the system could raise the pressure on the other side to 1,000 volts. For this reason, primarily, it was decided to adopt the method of two 500-volt generators with the middle point connected to the running rails. Further, this method and the sub-station reducers allow all the advantages of a 2,000-volt continuous-current distribution in which no commutator has more than 500 volts maximum across its brushes.

The units are divided up as follows:—Two Willans engines direct-connected to 125-KW. generators; two 3-R Willans engines coupled to 300-KW E.C.C. generators; two 800-KW. E.C.C. generators direct-coupled to Corliss engines made by Messrs. Cole, Marchent & Morley, of Bradford; and a Ferranti-E.C.C. direct-connected set of 400-KW. capacity. Experience showed that there was a decided economy in steam consumption in favour of the Corliss engines, but the Ferranti engine seemed to combine the advantages of the Corliss in the matter of valve-gear and steam-consumption, with the low cost and small space of a Willans direct-coupled set.

With the exception of the Siemens generator which was removed from the old station, all the new machines are multipolar, and made by the Electric Construction Co., of Wolverhampton.

The old Edison-Hopkinson generators, which originally supplied current for the railway, were removed to the new station and coupled up as motor-generators.

A double booster was installed to compensate for the voltage drop in the Kennington feeders, but, except in cases of very heavy loads,

* A fully-illustrated description of the new station was published in our issue of September 7th, 1900, pp. 381—389.—Eds.

it is found that the voltage on the line is so steady, that the booster is not run continually.

All the engines exhaust into a cast-iron main 32 in. in diameter, fitted with an automatic relief valve. The condenser is of the "surface" type, with Edwards steam-driven air-pumps and two centrifugal circulating pumps.

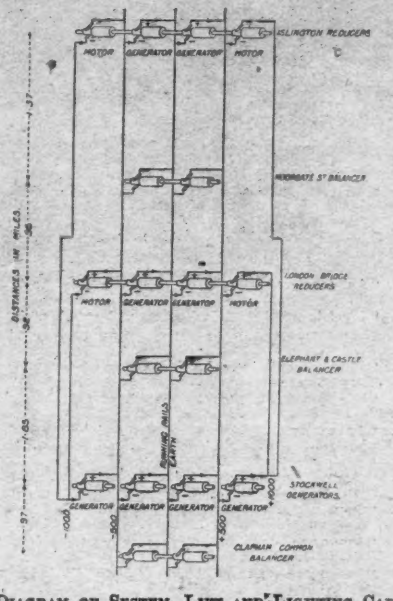


Fig. 1.—Diagram of System, Lift and Lighting Cables Omitted.

There are two cooling towers, the larger one a Klein tower, the other designed by Mr. Druitt Halpin. With the exception of the latter, the whole of the condensing plant and piping was supplied by Messrs. Cole, Marchent & Morley, Bradford.

The three-wire system, with the arrangement of 2,000-volt distribution to the sub-station, in reality is a sort of five-wire system.

The old line from Stockwell to King William Street, a distance of 3 miles 12 chains, was successfully worked on the two-wire system for nine years, but with the extension to the Angel, coupled with a quicker service and heavier trains, it was necessary to abandon this method of distribution with all its simplicity.

Before coming to a decision in the matter, all possible systems were considered, and it seemed to the author that the three-wire system with accumulator sub-stations would satisfactorily meet the case. After a couple of years' experience with this system it can fairly be said that the City and South London Railway is a successful example of continuous current distribution at high voltage.

The diagram, fig. 1, shows the system in its simplest form. The up and down working conductors with the running rails as the middle-wire form the three-wire system pure and simple, the 500-volt generators being on either side of the system. To supply the sub-station another generator, either steam or motor-driven, adds an additional 500 volts to an additional set of high-tension bus-bars from which the two sub-stations are fed at 1,000 volts above the rail potential, or 2,000 volts across the outers. The pressure is reduced at the sub-station by special E.C.C. reducing transformers in which only half the energy is transformed and the cable drop compensated for.

In the old days the steadiness of the light in the carriages was far from satisfactory, and this was due in a great measure to the bad governing of the main engines and to the drop in the cables and small working conductor. When designing the new plant great stress was laid upon having an absolutely steady voltage on the working conductor under all conditions of load. In the first place, very close governing of the engines was insisted upon, and fortunately obtained, as shown by the recording voltmeter charts on the switchboard. Fig. 2 shows that the voltage is absolutely steady under all conditions of load.

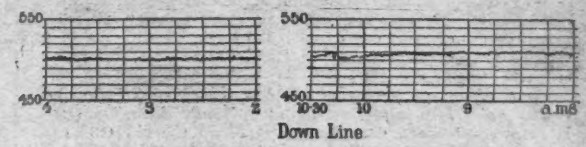


Fig. 2.—Bus-bar Volts, 8—10.30 a.m. and 2—4 p.m.

The first feeding point chosen was Stockwell, where the voltage drop between the working conductor and the switchboard was practically *nil*. The next point is Kennington, 1·31 miles from Stockwell.

The above sub-station, 2·77 miles from Stockwell, forms the third feeding point, and the Angel sub-station, 5·12 miles from Stockwell, is the fourth. This feeding point at the extreme end was chosen as a farther extension to Euston is under contemplation.

On the left-hand side of the main switchboard are arranged the generator panels, each machine having a separate panel. The bus-bars run along the entire length of the board, the top bus-bar being connected with the "up tunnel," the bottom with the "down tunnel," and the middle bar with the running rails. Either generator can be connected to the "up" or "down" side of the system, but the switches are interlocked so that it is impossible to connect any one machine with both "up" and "down" sides at one time. Each feeder panel contains the up and down feeders, as in the case of the generator. The first feeder panel being that of the Stockwell feeder, both up and down contain an ammeter, automatic circuit-breaker, and a knife switch, the latter being required as the circuit-breaker does not entirely break the circuit, but, when a short circuit occurs, throws in a resistance which limits the current to the maximum load for which the feeder is designed. This method of throwing in a resistance instead of breaking the circuit has many advantages; it saves the switch contacts, allows the switchboard attendant to see whether the "short" is removed before replacing the automatic circuit-breaker, and also leaves the current on the working conductor, so that in most cases the locomotive is able to

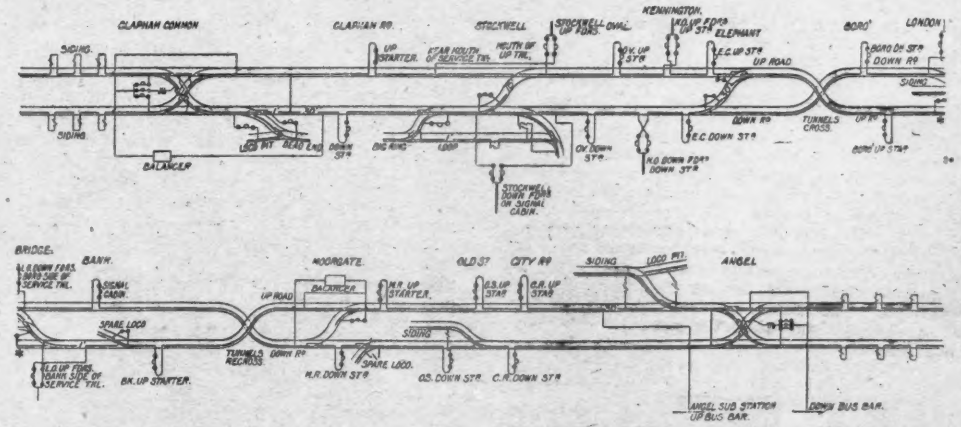


Fig. 3.—Diagram of Working Conductor, Showing Section Switches and Fuses.

reach the next station at low voltage. The train lights are prevented from going out completely, which, from the passengers' point of view, is very important. All the circuit-breakers, both generator and feeder, with the exception of the high-tension feeders, are similarly arranged. The Kennington feeder panel has, in addition, a starting resistance for the booster, and change-over switches, so that the feeders can be used with or without the booster, as required. The following panels contain the starting and switching gear for the motor side of the motor-generators which are used for supplying current to the sub-stations, and the last panel contains an automatic circuit-breaker without resistance, which separates the high and low tension switchboards in case of a heavy short-circuit. On the same panel switches are arranged so that the motor-side of either motor-generator can be fed from both sides of the system as required. In the ordinary way it is usual for the generator supplying the "up" high-tension bus-bars to take current for its motor from the "down" low-tension bus-bars, and the "down" generators motor receives current from the "up" low-tension bus-bars. This

arrangement is adopted to assist in balancing, but it is sometimes convenient to feed both motors from the same side, should there be a large generator working on one side and a smaller one on the other.

In addition to using motor-generators for the high-tension service, it is possible to use either of the 125 or 300-kw. sets, singly or in parallel. The first panel of the high-tension board contains the necessary paralleling switch-gear for the above purpose, and the next two panels contain the feeders for London Bridge and the Angel sub-stations respectively. All feeders are protected with automatic circuit-breakers and main switches.

A separate board on the extreme left of the main board contains the switch-gear for the light and lift cables in connection with a battery on the Highfield system.

All the cables with the exception of the Kennington feeders, which consist of the original Fowler-Waring cables, re-laid, are of the well-known Callender make.

The Stockwell feeders are two 0·32 sq. in. lead-sheathed and compounded cables in parallel for both "up" and "down" sides. The Kennington feeders, as already stated, are the old 0·32 sq. in. cables re-laid, two in parallel, for each side of the system. In the London Bridge sub-station four high-tension, lead-covered and

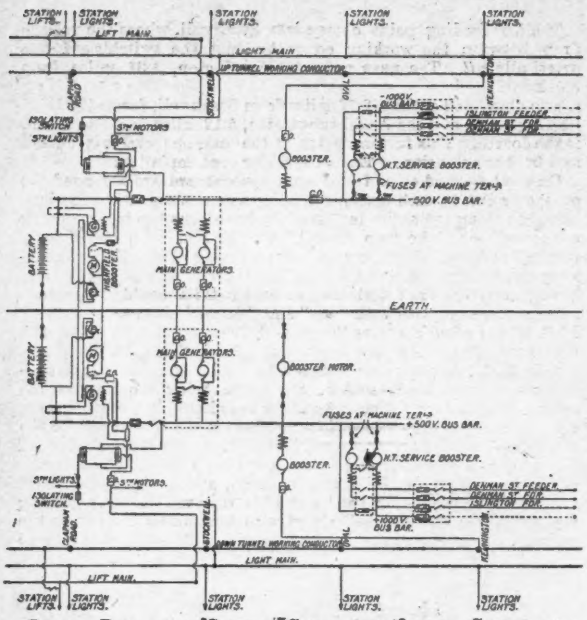


FIG. 14.—DIAGRAM OF SYSTEM. [GENERATING STATION CONNECTIONS.

armoured cables of 0·35 sq. in. are used—two in each tunnel, or one cable for each reducer. The Angel sub-station feeders are similar to the above, but only two are at present installed, provision being made for a second set when required.

The diagram fig. 3 of line connections shows the method of dividing the working conductor into sections. At each station there is a switch fuse, and at Stockwell, Kennington, London Bridge and the Angel, the feeders are connected to the working conductor through a double switch fuse. At the sidings additional switches are provided for breaking the working conductor into smaller sections, for repairs to carriages, &c. Diagram fig. 4 gives the connections at the generating station.

(To be continued.)

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

26,687. "Improvements in electric lamps for motor-cars and vehicles." R. LEE. December 7th.

26,773. "Improved arc lamp, with convergent downwardly directed carbons." T. L. CARBONE. December 7th. (Complete.)

26,783. "Improvements in electrically operated railway switches." C. W. BREEDLOVE and R. R. GRANT. December 7th. (Complete.)

26,788. "Improvements in electric motors of the induction type." F. M. LEWIS. December 7th.

26,808. "Improvements relating to telegraph poles and the like." W. L. BULLOWS. December 8th.

26,827. "Improved wind motor for the generation of electricity, and for other purposes." D. BURNS and J. M. FLEMING. December 8th.

26,842. "Improvements in electric automatic cut-outs or switches." CROMPTON AND CO., LTD., and A. J. HODGSON. December 8th.

26,843. "Improvements in arc lamp suspension apparatus." CROMPTON AND CO., LTD., and A. J. HODGSON. December 8th.

26,848. "Telephone systems." W. FAIRWEATHER. (The Stromberg Carlson Telephone Manufacturing Co., United States.) December 8th. (Complete.)

26,849. "Telephone systems." W. FAIRWEATHER. (The Stromberg Carlson Telephone Manufacturing Co., United States.) December 8th.

26,851. "Improved central exchange apparatus and connection." W. FAIRWEATHER. (The Stromberg Carlson Telephone Manufacturing Co., United States.) December 8th. (Complete.)

26,856. "Improvements in and relating to electric circuit-breaker mechanism." CROMPTON & CO., LTD., and R. C. HARRIS. December 8th.

26,857. "Improvements in electric arc lamps." CROMPTON & CO., LTD., and A. J. HODGSON. December 8th.

26,863. "Telephonic recorder." S. ROWE. December 8th.

26,912. "Improvements in or connected with incandescent electric lamps." G. DAVIS. December 9th.

26,913. "Telephone exchange systems." J. SWINBURNE and G. H. BAILLIE. December 9th.

26,915. "Improvements in connection with wall sockets and switches for electric circuits." G. E. FLETCHER. December 9th.

26,916. "Improvements in means for advertising on electric tramcars and other electric vehicles." A. E. WALKDEN. December 9th.

26,922. "Improvements in connection with the laying of electric cables and the like." W. M. ROGERSON. December 9th.

26,935. "An electrical controller." D. E. EVANS. December 9th.

26,947. "Improvements in automatic electric street indicators for cars." F. H. WEHRMANN. December 9th. (Complete.)

26,954. "A mechanical device applied to the cars or cages of electrically-driven lifts and belt-driven lifts." A. C. MOFFATT. December 9th.

26,961. "Improvements in switching mechanism for double filament electric lamps." J. MCCULLOUGH. December 9th. (Date applied for under Patents Act, 1901, December 10th, 1903, being date of application in United States. (Complete.)

26,965. "An improved clutch for electric arc lamps." H. B. SWIFT. December 9th.

26,967. "Electric switch." A. E. WEDELIN. December 9th.

27,032. "Improvements in dynamo-electric machines." H. CHITTY December 10th

27,038. "Improvements in sand valve, gear, and tramp for use on electric cars." H. LIDDLE. December 10th.

27,118. "Improvements in the collector pulleys of overhead electric railways." R. BOSTOCK. December 11th.

27,131. "Improvements in or in connection with trolley poles used on electric tramcars and similar vehicles." J. W. WILKINSON. December 11th. (Complete.)

27,153. "Controlling apparatus for electric signalling devices." J. T. MITSCHERLING. December 11th. (Complete.)

27,171. "Improvements in or relating to the methods of insulating electrical coils, conductors and the like." H. CHITTY. December 11th.

27,189. "Improvements in means for controlling the voltage from an electric generator." I. DEUTSCH December 11th. (Complete.)

27,196. "Improvements in electric switches." C. E. HUNTER. December 11th. (Complete.)

27,249. "Improvements in apparatus for collecting, separating, drying, or similarly treating oxygen and hydrogen generated by electrolysis of water." P. GARUTI and C. R. POMPILI. December 12th.

27,265. "Improvements in and relating to telegraph and like cables." SIR O. J. LODGE and A. R. HARDIE. December 12th.

27,283. "Improvements in and connected with counters for electric current meters, gas meters, water meters and the like." F. BIERMANN. December 12th.

27,173. "Connector for electric circuits." W. H. KELSEY. December 11th.

27,267. "Improved means applicable for use in suspending electroliers." L. MILNE. December 12th

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1902.

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REGULATING THE CONSUMPTION OF CURRENT BY ELECTROMETERS. Siemens Bros. & Co., Ltd. (Siemens & Halske Actien-Gesellschaft.) 20,615. September 22nd.

ELECTRIC ARC LAMP. Jandus Arc Lamp and Electric Co., Ltd., and A. D. Jones. 21,346. October 1st.

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SOCKETS FOR SAFETY FUSES FOR ELECTRIC LEADS. Siemens Bros. & Co., Ltd. (Siemens & Halske Actien-Gesellschaft.) 22,107. October 10th.

ELECTRICAL SAFETY FUSES. Siemens Bros. & Co., Ltd. (Siemens & Halske Actien-Gesellschaft.) 22,108. October 11th.

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